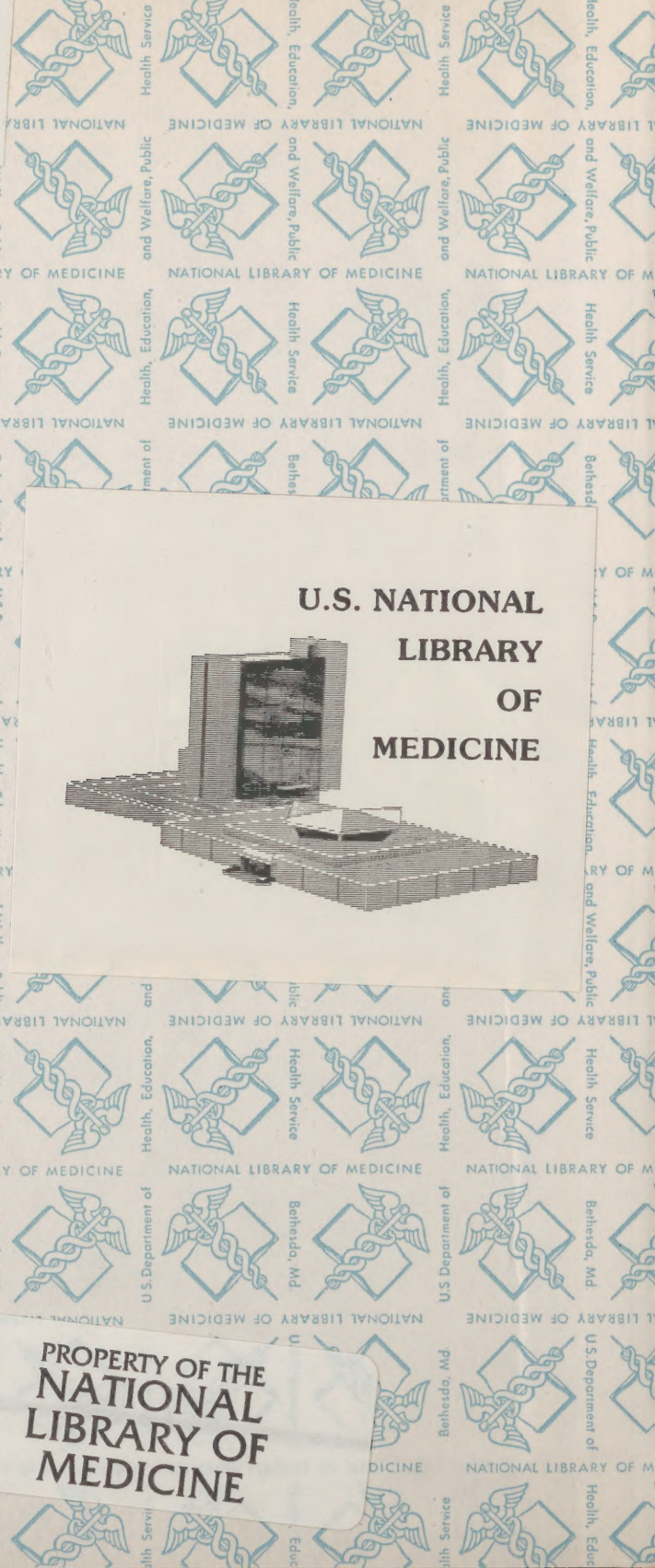


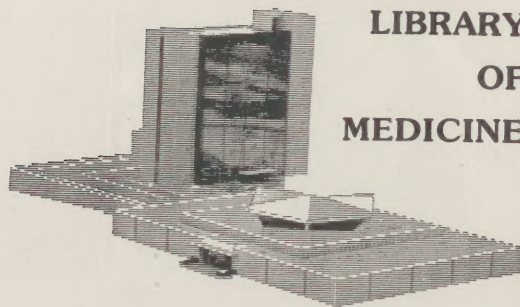


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LEAD POISONING

(A compilation of present knowledge)

By

R. M. HUTTON

Division of Industrial Hygiene

August, 1923

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TO THE HONOURABLE FORBES GODFREY, M.D.,
Minister of Health and Labour.

SIR,—

I have the honour to submit for your approval this publication, "Lead Poisoning—Compilation of Present Knowledge," brought out by the Division of Industrial Hygiene.

I have the honour to be,

Sir,

Your obedient servant,

JOHN W. S. McCULLOUGH,
Chief Officer of Health.

Toronto, August, 1923.

PREFACE.

THIS book, which is, as the title states, a compilation, is the first on the subject to be written in this country. It has been prepared for the use of plant physicians, health investigators, and others interested in industrial well-being, with the object of collecting into small compass the main facts at present known concerning the causes, incidence, recognition, prevention and treatment of lead poisoning.

Such a book is a valuable, and indeed a necessary, preliminary to the task of controlling lead poisoning in Canada, for it makes available in brief, compact, and clear form the great wealth of practical experience and scientific knowledge of the subject which has been slowly and painfully acquired in other countries. It may also have a wider field of usefulness, for a subject such as lead poisoning, in which so much work has been and still is being done all over the world, cannot fail to be advanced by a compilation bringing together the scattered, and often inaccessible, scientific and statistical data from the text-books and periodicals of many countries. That some such book was called for at the present moment may be judged from the fact that the main text books on lead poisoning date in every instance from before 1914. More recent contributions to the subject have, with the exception of a few instances of chapters in books on general occupational disease, taken the form of articles in scientific and industrial periodicals or government reports. To garner the grain from such a widely scattered harvest is an arduous task, but one well worth doing.

The book contains nothing original and the author, Miss R. M. Hutton, who is not a member of the medical profession, has acted throughout as collector and, to coin a phrase, "quantitative evaluator" rather than as "qualitative evaluator." Where conclusions are drawn they are based on the general consensus of authoritative opinions; on controversial points the evidence is simply recapitulated and the disputants grouped according to their views. Such a method, together with the very careful and full system of references, makes the book both a handbook for the industrial physician for practical purposes and, at the same time, a directory of the literature for any one desiring further knowledge.

J. J. R. MACLEOD, *F.R.S., M.B., D.P.H.*

INTRODUCTION

LEAD poisoning is the most important industrial poisoning, there being upwards of 150 different trades in which workers are exposed, and these including such staple industries as the manufacture of white lead, lead smelting and rolling, the manufacture of storage batteries, pottery and printing. Scientific knowledge of lead poisoning, its symptomatology and pathology and the laboratory and clinical tests for lead in organic substances, is also more advanced than is the case with poisons whose menace is less widespread. The experience of countries such as Great Britain, Germany, Austria and others shows that both the incidence and the severity of lead poisoning can be very greatly diminished by regulation of plant conditions and medical supervision of workers. Finally, the "literature" on lead poisoning is exceptionally voluminous and is daily being increased. For these reasons it was felt that a small book covering the field in outline and bringing together much widely scattered data would be of great practical use to the plant physician whose working library is necessarily limited. Then, too, frequently a publication dealing with the hazard in one lead trade contains much material of value for the general aspects of the problem of lead poisoning. Here, recapitulation or reference under the suitable subject heading is an obvious benefit. The book is exceedingly fully annotated and there is a very complete classified bibliography.

Sources used.

The material for this compilation has been taken from:

- (a) Recognized text books on lead poisoning;
- (b) Portions bearing on lead in general occupational disease books;
- (c) Articles in the scientific and industrial journals of England, U.S.A., and the main European countries.

As regards the latter, chief reliance was placed on the abstracts of the Journal of Industrial Hygiene, Harvard Medical School, Boston.

- (d) Annual reports and statistics from government departments;
- (e) Government reports on surveys, investigations and scientific research.

Acknowledgments.

The Division of Industrial Hygiene has incurred many obligations from a great variety of associations and individuals in many countries. In especial it is desired to acknowledge indebtedness and record thanks to the following, either for permission to reproduce or abstract work at considerable length, or for information on special points, or for general interest and courtesy:

Sir Thomas Oliver, England.

Dr. Alice Hamilton, U.S.A.

Dr. E. R. Hayhurst, U.S.A.

The authors of "Lead Poisoning in the Pottery Trades" (B. J. Newman, W. J. McConnell, O. M. Spencer, and F. M. Phillips).

The editors of the Journal of Industrial Hygiene, Boston.

The American Association of Labour Legislation.

Le Ministère du Travail, Paris, France.

La Division de l'Industrie et des Arts et Métiers, Berne,
Switzerland.

With regard to the legislation section, for a great portion considerable use has been made of "Laws and Regulations relating to Lead Poisoning," by Gilbert Stone, published by the Imperial Mineral Resources Bureau in 1922. Other portions, most notably the chapters on U.S.A. and Canada, are a fresh survey of the position based on documents and information supplied by the respective governments.

The book is the work of Miss R. M. Hutton and has been done with the assistance and advice of Dr. J. G. Cunningham, Director of the Division of Industrial Hygiene.

Chapter II on pathology is the work of Dr. N. C. Sharpe, Clinician, Division of Industrial Hygiene, and chapter IV on Laboratory and Clinical Tests for Lead is the work of Mr. W. E. Green, Chemist, Division of Industrial Hygiene.

JOHN W. S. McCULLOUGH,
Chief Officer of Health.

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Part I

FOREWORD

CHEMISTRY OF LEAD

Lead (plumbum) occurs in nature principally as the sulphide, galena, but it is also found as the sulphate, phosphate, carbonate, chromate, molybdate, tungstate and arsenate.

Pure metallic lead has a bluish-white colour, is soft, very malleable and tolerably ductile. It can be scratched with the human nail, easily cut with a knife and makes a streak on paper. On account of its softness, malleability and low melting point (327°C.), lead is an extremely useful metal for casting type, pipes, ornaments, etc. A freshly cut surface has a bright lustre, but on exposure to air becomes dull by oxidation. In contact with air and pure water, lead oxidizes to lead hydroxide, $\text{Pb}(\text{OH})_2$. If, however, carbonic acid or mineral salts are present even to the same extent as in natural waters, no lead dissolves but it soon becomes coated with an insoluble layer of lead carbonate and sulphate.

The compounds of lead which are responsible for poisoning in industrial processes are for the most part the hydrated carbonate or white lead, and the oxides of lead. A few cases are due to chromates and chlorides.

The following lead compounds may be met with:

(1) *Suboxide*, Pb_2O —the gray pellicle which forms on the surface of lead exposed to air.

(2) *Protoxide or Monoxide*, PbO —consists of 92.82% lead. It melts at a red heat and after fusion it solidifies to a reddish-yellow mass of crystals known as "litharge." If prepared below the melting point, the oxide is called "massicot."

(3) *Sesquioxide*, Pb_2O_3 —reddish-yellow powder.

(4) *Dioxide or peroxide*, PbO_2 —a dark brown amorphous powder.

(5) "*Red lead*," Pb_3O_4 —sometimes called "minium." It is a bright red powder.

(6) *Lead carbonate*—"white lead," $2\text{PbCO}_3 \cdot \text{Pb}(\text{OH})_2$ —It is a basic carbonate of lead formed by the combination of neutral lead carbonate with variable proportions of lead hydroxide.

(7) *Lead chloride*, PbCl_2 —74.48% lead, almost insoluble in cold water but crystallizes from boiling water in the form of white shining needles.

(8) *Lead sulphate*, PbSO_4 —73.61% lead. It occurs in nature as anglesite in rhombic crystals. It is precipitated from lead solutions by sulphuric acid as a white crystalline substance. It can be changed to the carbonate by boiling with alkaline carbonates. When fused with potassium cyanide it yields metallic lead. It is practically insoluble in water.

A solution of lead sulphate in sulphuric acid when boiled deposits acid lead sulphate. $\text{PbSO}_4 \cdot \text{H}_2\text{SO}_4 \cdot \text{H}_2\text{O}$. Ammonia precipitates a basic lead sulphate $\text{PbSO}_4 \cdot \text{PbO}$ from a solution of a lead salt.

(9) *Lead nitrate*, $\text{Pb}(\text{NO}_3)_2$ —obtained by dissolving lead in dilute nitric acid. It crystallizes in cubic system and is soluble in two parts of water at the ordinary temperature.

(10) *Lead chromate*, PbCrO_4 —used as a pigment and known commercially as “chrome yellow.” It is slightly soluble in water.

(11) *Lead acetate*, $\text{Pb}(\text{C}_2\text{O}_2\text{H}_3)_2 \cdot 3\text{H}_2\text{O}$ —known commonly as sugar of lead on account of its sweet taste. Since it is readily soluble in water, it is the lead salt most used in the arts. It is obtained by the action of acetic acid on lead oxide.

CHAPTER I

ÆTIOLOGY OF LEAD POISONING

All lead compounds dangerous

With the possible exception of the silicates, lead in any form can produce poisoning. Lead acetate, the oxide, the basic carbonate, the chromate, the chloride, the nitrate, the sulphate, and the sulphide, are all poisonous. Much the least poisonous is the sulphide, which was for long generally accounted harmless, and is still so accounted by some, notably by Rambousek, who says "Lead sulphide is, in spite of various assertions to the contrary, practically non-poisonous; a fact attributed to its insolubility in water and weak acids."

The relative dangers of the different compounds*

Danger is in proportion to both solubility and capacity for forming dust. For some time greater importance was attached to solubility, but modern English opinion holds that the chief dangerous factor is the dustiness. The oxides, the basic carbonate, the chromate, the sulphate and the monosilicate are all dusty and some of them very light and fluffy; the acetate, which is very soluble, is sticky rather than dusty.

The most poisonous compounds

(1) The Suboxide (Pb_2O)

"Probably the most poisonous lead compound used in industry is the suboxide (Pb_2O), that fine, light gray powder given off in fumes from heated lead. This is so light that it is carried into the air by the waves of heat, and so finely divided that it is easily absorbed when breathed and swallowed. It is this oxide which causes poisoning in lead smelters, zinc smelters, brass moulders, and to a less extent in workers with molten lead such as lead moulders, lead burners, stereotypers, electrotypers, and those employed in making lead pipe and wire, sheet lead, shot, and the makers and users of solder. It is this same oxide that forms a grayish coating on solid lead, and rubs off on the hands. Men who handle solid lead sometimes get a very slow chronic form of poisoning from this oxide."

(2) and (3) Litharge (PbO) and Red Lead (Pb_3O_4 or Pb_4O_6); and White Lead ($2\text{PbCO}_3\cdot\text{Pb}(\text{OH})_2$)

It is difficult to say whether litharge and red lead, or white lead is the more dangerous. White lead is responsible for more poisoning, owing to its wider use, and is decidedly more soluble, but litharge and red lead are lighter and more fluffy and perhaps more harmful. The most dangerous white lead industries are the manufacture of white lead, the painting trade and the glazing of pottery. Litharge and red lead are used in the manufacture of storage batteries and enter into the composition of rubber, glass, varnish, some pottery glazes, enamel for sanitary ware and paint for structural iron and steel work, etc.

1 Rambousek, *Industrial Poisoning*, translated by Legge, 1913, p. 293.

* The whole of this section, with subheads 1-5, is taken almost direct from Alice Hamilton, "Women in the Lead Industry," U.S. Bur. Lab. Stats., 1919, Bull. No. 253, pp. 13, 14.

(4) and (5) Lead Sulphate and Lead Chromate

These are almost equally poisonous.

For experiments showing the relative toxicity of basic lead sulphate and basic lead carbonate, *see* Appendix A.

(6) Lead Sulphide

This is by far the least poisonous compound and Rambosek's view quoted above is commonly held. Dr. Hamilton, however, cites Müller as reporting a case of poisoning in a man who had been exposed to sulphide ore only, and also considers that there is evidence for the belief that 25 cases of lead poisoning treated in 1912 in a St. Louis hospital were all contracted during work in mines or concentrating mills where sulphide ore only is handled.

The view that lead sulphide is harmless is based on its alleged insolubility in the human body. For the experiments of Dr. Carlson and Dr. Woelfel of the Physiological Department of the University of Chicago, testifying to its solubility, *see* Appendix B.[#]

The dangerous forms of lead: Dust the chief hazard

Lead is poisonous in dust, in fumes, and, according to some writers, in contact by skin absorption. Most if not all authorities are now agreed that the chief danger is from dust, and it is on this premise that modern precautions against poisoning are being based.

Lead melts at 325° C., and vaporizes at 650° C., if there is no slag on the surface to prevent the escape of the oxide.¹

Entry of lead into the body

There are three possibilities of entry:

(1) By the respiratory organs reaching either (a) the lungs or (b) the alimentary canal.

(2) By ingestion through the mouth to the alimentary canal.

(3) By the skin.

(1) Entry by the respiratory organs

Practically all authorities are agreed that entry by the respiratory organs is by far the most common, but they differ as to whether the dust thus breathed more commonly reaches the lungs or the alimentary canal.

Legge and Goadby hold that the lead inhaled through the respiratory organs enters the bronchial tubes and lungs, thence penetrating the capillaries and thus reaching the blood stream.² Oliver, on the other hand, while acknowledging that some of the fine particles are carried into the lungs, considers that the amount must be small, and holds that most of the lead dust breathed is caught in the mouth or throat, there dissolved in saliva, swallowed and conveyed into the alimentary canal. Most German authorities agree with this and in certain experiments conducted by Professor K. B. Lehmann, of Wurzburg, and his assistant, Saito, only 12% of the lead dust inspired was found in the lungs, 70% in the alimentary canal. Dr. Hamilton also accepts this finding and agrees with Oliver's view.

At the same time, however, it must be noted that in the feeding and inhalation experiments of Legge and Goadby³ animals exposed to inhalation of lead dust developed poisoning far more quickly than the animals which were being

¹ Oliver, *Lead Poisoning*, 1914, p. 166.

² Quoted by Alice Hamilton, *Hygiene of the Painter's Trade*, U.S. Bur. Lab. Stats., 1913, Bull. No. 120, p. 34

³ Legge and Goadby, *Lead Poisoning and Lead Absorption*, 1912, p. 86 and p. 98.

fed at least ten times as much lead as the other animals could get by inhalation. Apparently small quantities of lead reaching the lungs are much more apt to produce poisoning than larger quantities reaching the stomach.

Judgment between the two schools of thought is unnecessary from the primary point of view of industrial hygiene, that is prevention, since whether lead dust is most apt to reach the lungs or the alimentary canal, it is agreed that the chief source of poisoning is the breathing of dust and that it is against this that prevention should be mainly directed.

(2) Entry by ingestion through the mouth to the alimentary canal

Until very recently this means of entry was assumed to be the most important, and, as an inevitable result of the assumption, preventive measures were chiefly concentrated on guarding this port of entry by training workers not to convey lead to the mouth by eating with dirty hands, smoking at work, etc. The authoritative and widespread nature of this view, which is now being extensively modified, may be judged by an extract from the evidence of the British Government inquiry in 1907 into building accidents, in which the assumption of the questioner is confirmed by the opinion of the practical expert. The question put was, "I assume the painters understand that lead poisoning is largely a matter of cleanliness on their part," and the answer, by Mr. Gardner, Secretary of the Scottish Society of Operative House and Ship Painters, "Oh, yes, if a man has painter's colic, it is to a great extent his own fault, generally speaking—it is generally due to uncleanness on his part."

The radical change in thought which has taken place since 1907 is seen in the report dated 1914 of the British Departmental Committee on the danger in the use of lead in the painting of buildings, which is signed by the Mr. Gardner referred to above. The committee based its investigations and finally its recommendations on the theory that entry by the respiratory system as a consequence of inhaling lead-dust laden air is by far the most dangerous to the worker¹; the risk entailed in entry by the alimentary system as a consequence of swallowing lead dust or lead-contaminated-food being "small but not negligible."² That the pendulum has swung full may be judged by the views of Sir Kenneth Goadby expressed during the proceedings of the same committee that "hot water for washing is not important,"³ and again, that "very little trouble is brought about by not washing hands."⁴ Few authorities go so far as Sir Kenneth Goadby. Oliver, Hamilton and Hayhurst still insist on the necessity for cleanliness, although they evidently consider this neither the sole nor chief preventive measure, provision for which can in any way relieve employers from their responsibilities, but a supplementary measure which should be placed well in the reach of each employee and of which he should avail himself. The modern point of view can perhaps be most briefly summed up in the words of Dr. Legge: "My feeling about that (*i.e.*, provision for cleanliness) always is this, that unless you can go to a fountain head of the mischief, the dust, and stop that, you are not going to secure much improvement by all the personal cleanliness in the world."⁵

In order that side by side with the English view we may have the American, Dr. Hamilton's recently expressed opinion may be quoted. After speaking of the theory that the worker "poisons himself" by neglect of personal cleanliness

¹ Report of the British Departmental Committee on the Danger in the Use of Lead in the Painting of Buildings 1914. Reprinted by U.S. Bur. of Lab. Stats., Bull. No. 185, p. 125.

² *Ibid.*

³ Reference by Mr. Sutherland in Memo. to Reports of British Departmental Committee on Danger in the Use of Lead in the Painting of Buildings, etc., Vol. I, and Minute 22063 in Vol. IV of the same reports.

⁴ *Ibid.*, and Minute 22056.

⁵ Reports of British Departmental Committee on Danger in Use of Lead, Vol. IV, Minute 273.

as the "most common superstition" concerning industrial plumbism, she refers to the experiments of Richard Müller, the head of a model lead smelter in Germany, who found that a blast furnace tapper could breathe as much as 1.0625 gms. of lead in a 10-hour day, but that it was possible to wash off his hands only 0.0876 gms. Dr. Hamilton concludes, "unless a worker literally washed his hands in his soup or coffee he could not get even all of that (0.087 gms.) into his mouth."¹

Obviously this change in principle is of the utmost practical importance since those who accept it will direct their chief preventive measures at elimination or removal of dust, either by substituting less dusty processes for dust-producing ones, or by perfecting systems of exhaust ventilation. The field thus indicated is, of course, a very extensive one, opening up endless lines for research and experiment and necessitating individual study of the problems of dust prevention for every separate lead industry and countless separate processes. The complexity of the modern problem makes it incapable of solution by any standard method, as, for instance, the installation of washing facilities of adequate quantity and quality, and it is evident that the problem is likely to continue a current one, requiring re-statement and re-solution, for precisely so long as industry continues to develop new processes of production.

And as the scope of the problem has been enormously increased, so the burden of responsibility has been largely shifted, and the view that a worker who incurs poisoning has chiefly his own uncleanness to blame becomes not only untenable but absurd. With all the observance of "personal hygiene" in the world, a man cannot at present entirely prevent himself either from inhaling lead dust in the air around him or from suffering as a result of such inhalation. The question of respirators has been dealt with elsewhere, but in this connection the view of Müller, that it is impossible for a workman to get enough air through a really effective dust-filtering respirator, may be referred to.²

(3) Entry by absorption through the skin

The question here is of entry through the unbroken skin, and the weight of opinion is that in practice, as regards industry at any rate, the amount thus entering is so small as to be negligible. The cases of industrial lead poisoning by this method sporadically reported in the literature are too few to controvert this view, especially when considered in relation to (a) the frequent opportunities offered to this mode of entry, and (b) the element of personal idiosyncrasy which is so characteristic a feature of the lead poisoning problem.

Among the instances reported, the following may be cited: Boulin³ refers to a workman who contracted paralysis of the muscle of the shoulder on which he carried pigs of lead, and to another who developed paralysis of the feet after habitually walking barefoot over sheet iron. Eichhorst⁴ has two similar examples of unilateral radial paralysis, one in a dyer and one in an armourer, both from constant dipping of their respective products into lead solutions.

Oliver speaks of the skin as "an uncommon mode of entrance of lead into the body"; Dr. Hamilton refers to it as "negligible"; Hayhurst as "largely denied"; Goadby in his evidence before the British Departmental Committee on the Danger in the Use of Lead in the Painting of Buildings, is reported as saying, "no absorption through the skin."

¹ Alice Hamilton, *Lead Poisoning in American Industry*, J.I.H., May, 1919, pp. 8-21.

² Alice Hamilton, *Lead Poisoning in the Smelting and Refining of Lead*, U.S. Bur. of Lab. Stats., 1914, Bull. No. 141, p. 16.

³ Pierre Boulin, *Les Fonderies de Plomb*, Paris, 1907.

⁴ Eichhorst: *Über Bleilämung*.

It must be remembered that the *possibility* of absorption through the unbroken skin is not denied. W. H. Rand¹ points out in this connection that the argument as to impermeability of the skin to lead put forward by some is based on animal experiments and accordingly valueless, since no analogy drawn from the action of lead on a non-perspiring animal can be applied to a perspiring animal such as man. Oliver cites cases of lead poisoning among non-industrial patients from the use of cosmetics and hair dye, and Legge and Goadby conclude that "there is no reason to exclude lead from the category of drugs which may be absorbed through the medium of the skin."² The apparent discrepancy between this view and that of Goadby's quoted just above is explained by the fact that in the second reference Goadby is considering the permeability of the human skin to lead as a medical problem, in the first the actual danger of absorption through the skin in industry. As has been seen, the general consensus of opinion is that the danger is negligible. The chief guidance to be drawn from instances of absorption which may be met with lies on the line of excluding from lead work such individuals as are unusually susceptible to lead.

Dangerous amounts of lead

No authority has yet arisen to dispute the theory that it is the continued daily inhalation of small quantities of lead rather than an occasional or single larger dose which causes poisoning. Oliver explains this by showing that poisoning arises from the dissolution and absorption of lead into the organs, tissues and blood. "Small quantities of lead can always be readily dissolved in, and be also readily absorbed from, the stomach . . . larger quantities would be less likely to be dissolved and absorbed. . . . Where large doses of lead are given by the mouth, *e.g.*, 15-20 grains of acetate of lead, only a minute quantity of this is likely to be absorbed. The bulk of it is thrown out in the faeces, but in the case of a lead worker who is breathing or swallowing dust, minute quantities only reach the internal economy at one time. As in the latter instance exposure to the metal continues for months or years, considerable quantities of lead can be absorbed over the extended period."³

The practical question arising is, of course, what amounts of lead inhaled as either fume or dust are harmful. The views of Legge and Goadby on this point are expressed as follows: "Somewhere about 2 milligrammes, or 0.002 grammes, of lead we regard as the lowest daily dose which, inhaled as fume or dust in the air, may in the course of years set up chronic plumbism."⁴ Dr. Ludwig Teleky, of Vienna, states that a daily dose of a little more than 1 milligramme of lead taken for several months will cause plumbism, and that a daily dose of 10 milligrammes will cause severe symptoms in a very short time.

To amplify this question of the amount calculated to set up severe symptoms, we have Dr. Legge's view that saturnine encephalopathy and paralysis will never, and colic rarely, occur if the amount of lead present in the air breathed is less than 5 milligrammes per 10 cubic metres of air.⁵

That industry presents many opportunities for the inhalation of dangerous amounts of lead can readily be proved by the simple method of measuring the

1 W. H. Rand, Occupational Lead Poisoning, U.S. Bur. of Lab. Stats., Monthly Labor Review, Feb., 1921, pp 135-148.

2 Legge and Goadby, Lead Poisoning and Lead Absorption, 1912, p. 25.

3 Oliver, Lead Poisoning, 1914, pp. 166 and 161.

4 Legge and Goadby, Lead Poisoning and Lead Absorption, 1912, p. 207.

5 Ibid.

lead content of air in the vicinity of a dusty process or fuming lead and then estimating the milligrammes of lead which might be inhaled on the basis of Teleky's calculation that 4.5 cubic metres of air are taken into the lungs in the course of ten hours. The following instances where such examinations were made, quoted by Oliver, are illuminating: "Tischler found 2.5 to 9 milligrammes of the metal in 100 litres of air removed from immediately above the reservoir of molten lead attached to a stereotyping machine, and Kaup found in the air of the drying-ovens in a white lead factory taken at the level of the lips of the workmen, 0.134 milligrammes of lead. Müller found in the air of a lead smelting works 236.8 milligrammes of lead in 100 litres of atmospheric air at the place where the men were working, and that after a hood had been erected, the air contained only 0.29 to 0.56 milligrammes of lead per 100 litres. If, as Teleky says, we consider that 4.5 cubic metres of air are taken into our lungs in ten hours—that is, during an average working day—the amounts of lead inhaled may be anything between 6 and 25.2 milligrammes. Kaup found in 100 litres of air in a white lead factory 0.122 to 0.271 milligrammes of lead; this, he believed, would give 5.49 to 12.2 as the amounts of lead in milligrammes which might be inhaled by workmen daily. In paint mixing and dry colour grinding, there may be 0.178 to 0.25 milligrammes of lead per 100 litres of air. Men exposed to such quantities of lead can hardly escape becoming lead-poisoned."¹

Practical conclusion on causes of poisoning

Leaving aside controversial points, it is possible to arrive at the following conclusions on the grounds either that they are generally agreed to by the greatest number of authorities or put forward by one authority as a working hypothesis and not as yet disputed.

Lead may be harmful in all its forms, though least in the sulphide. Practically, most poisoning is caused by dust, the danger from fumes being more easily prevented either by reduction of heat below the fuming point or by local exhaust system, and the danger from contact of the skin being slight, as evinced by the comparatively few instances of such poisoning reported. As regards dust, the danger is chiefly of entry through the respiratory organs, since a man inevitably breathes more dust than, short of deliberate intent, he could eat. This dust may reach either the lungs or the stomach, from either of which it may eventually reach the blood stream.

Continued daily inhalation of small quantities is more dangerous than an occasional large dose. The inhalation of 2 milligrammes of lead daily for some time in the form of fume or dust is capable of producing poisoning. Investigations have shown that workers are very frequently exposed to air containing enough lead to cause the daily inhalation of far larger quantities by inhalation alone. Their danger is increased by whatever additional amounts they may swallow through uncleanness and, in some cases, by the risk of skin absorption through handling lead.

Effects of poisoning apt to be cumulative

Symptoms appear when for one reason or another metabolism is upset and elimination falls short of absorption. Lead may be stored up in the body for years and give no trouble until metabolism becomes deranged and the inert lead becomes dissolved and reabsorbed into the blood.

Oliver² cites various striking instances of this sort where symptoms of lead poisoning appeared at intervals of 17 and 18 years after there had been exposure

¹ Oliver, *Lead Poisoning*, 1914, p. 167.

² Quoted by Gilman Thompson, *The Occupational Diseases*, 1914, p. 241.

to lead. His most remarkable example is of a woman who, when 19 years old, suffered from lead colic, blindness and paralysis, recovered, left work and had several children. After 17 years she was attacked by diplopia, headache and ocular paralysis, and was found to be eliminating lead in the urine.

Gilman Thompson¹ also reports the case of a woman who had decided lead line on the gums, granular basophilia, abdominal colic and partial wrist-drop after an interval of five years after exposure to lead which at the time had produced double wrist-drop.

Personal idiosyncrasy

It cannot be hoped to discover any set law as to the probable time after exposure to lead when symptoms of poisoning may be expected, since the development of symptoms, being intimately connected with the maintenance of metabolism, is subject to all the myriad subtle factors which affect health, and is further complicated by personal idiosyncrasy. With regard to the first point, it need only be realized that elimination of lead may at any time be checked owing to a countless variety of causes; and with regard to the second point, personal idiosyncrasy, it is clear that while the question is full of scientific interest, its only practical bearing in industry lies in the need of recognizing the existence of people of abnormal susceptibility to this form of poisoning and thence the wisdom of excluding such individuals from lead work while at the same time refraining from legislating with regard to the majority from the experience of the minority. Exceptional instances, diverging from the general laws of nature as seen operating in the majority of cases, must be treated as exceptional instances in the laws of civilization. Needless to say, before a man can be termed abnormally susceptible, it is necessary to rule out the possibility of his having incurred poisoning as the result of impaired metabolism, which in its turn may be traced to poverty and poor nutrition, alcoholic excess or the presence of some other disease and may be "preventable."

In the same factory and the same process there may often be found workers who during such long periods of exposure as 40 years have never been poisoned, side by side with workers who have contracted poisoning after only a few days' work. Examples of very rapid development, though not usually within a week, are noted in almost all the books and articles on the subject, and need not be repeated here, it being sufficient to observe that the examples are not confined to any one industry, but seem to be impartially distributed throughout the chief lead trades.

One writer with considerable experience of industrial lead poisoning is quoted by Dr. Hamilton as estimating that 20 to 30% of all lead workers are not susceptible (*i.e.*, practically immune), about 40% sicken quickly, and the remaining 30 or 40% sicken somewhat slowly. Dr. Hamilton's personal experience tends to lessen the numbers of the immune class. In two very dangerous white lead factories she found that only 10% and 12% respectively of the employees had been able to avoid poisoning for as much as 8 years.² Hayhurst also considers that probably not more than 10% are genuinely immune.

Lead poisoning and age

According to Dr. Hamilton, the question of the relative susceptibility to lead of adolescents is hardly a practical one in U.S.A., since very few adolescents

¹ Gilman Thompson, *The Occupational Diseases*, 1914, p. 241.

² Alice Hamilton, *Lead Poisoning in American Industry*, J.I.H., May, 1919, p. 16.

are to be found in American lead industries. The witness of countries which have experience on this point is that the immature are more susceptible than the mature. Legge and Goadby, dealing with this subject, say, "The general clinical conclusions of appointed surgeons in the various lead factories would be, we believe, that the susceptibility of young persons is at least twice that of adults, and there is some ground for supposing that the tissues of an adult, when growth has ceased, more readily adapt themselves to deal with the absorption and elimination of poisonous doses than do the tissues of a young person."¹

Lead poisoning and sex

Greater proportional incidence of lead poisoning among women than among men seems to be an international experience, but opinion differs as to the cause of this.

The British opinion, as represented by Oliver, Legge and Goadby, is that women are fundamentally more susceptible to lead than are men. Oliver² says, "So far as occupation exposure to lead is concerned, my opinion is (1) that women are more susceptible than men; (2) that while female liability is greatest between the ages of 18 and 23 years, that of men is later; and (3) that, while females rapidly break down in health under the influence of lead, men can work a longer time in the factory without suffering, their resistance apparently being greater."

German opinion³ tends to deny any inherent difference in susceptibility as connected with sex and ascribes the greater relative incidence of poisoning among women to (a) their greater poverty and malnutrition; (b) the increased strain from their liability to domestic work in addition to industrial work; (c) the greater facility for collection of dust offered by hair and feminine clothing.

American opinion has little data on which to base itself since women have never been employed in many of the most dangerous trades. Dr. Gilman Thompson holds the British view that females are more susceptible than men, but Dr. Hamilton refrains from expressing any final opinion, judging the figures available to be too few to be indicative. Certainly the number of cases of lead poisoning among women reported in the American literature is extremely small.

Gilman Thompson encountered only 1 in 268 cases seen in New York; Edsall, none in 98 cases in the Episcopal Hospital in Philadelphia; E. E. Pratt, 2 in 109 cases of serious poisoning in New York City; Hamilton, 18 in 578 cases referred to in the report of the Illinois Occupational Disease Commission; J. B. Andrews, 1 in the 60 reported deaths from lead poisoning in New York State in 1909 and 1910.

The American lead industries in which women are commonly employed include the following: manufacture of lithotransfer papers, finishing of glazed pottery and tiles, soldering tin cans, casting car seals, founding type, labeling paint cans, working with aluminum foil, manufacture of artificial flowers, wrapping cigars in tinfoil, work as commercial artists.

Women more subject to severe forms of plumbism

There is fairly general agreement that women are more subject than men to severe forms of lead poisoning, especially to the nervous and mental forms.

¹ Legge and Goadby, *Lead Poisoning and Lead Absorption*, 1912, p. 35.

² Oliver, *Dangerous Trades*, London, 1902, p. 296.

³ Agnes Bluhm in Weyl's *Handbuch der Hygiene*, 1897, Vol. 8, p. 88.

Prendergast,¹ a British physician with many years' experience in the Staffordshire pottery district, analyzes types of poisoning in 640 cases as follows:

	Men	Women
Colic.....	77.6%	69.8%
Paralysis.....	57.0%	30.0%
Convulsions.....	15.0%	34.9%
Blindness (total).....	2.3%	7.7%
Blindness (partial).....	3.5%	10.2%

Dr. Hamilton, in her investigation of American potteries and tile-workers, found that there were 87 cases of poisoning with 3 encephalopathies among 1,100 men and 57 cases with 13 encephalopathies among 450 women, or the rate of male poisoning was about 8% with only 1 in 17 brain forms, the rate of female 14% with 1 in 4 or 5 brain forms.²

Effects of lead on female functions

Most authorities refer to derangement in menstruation among women workers in lead, taking the form of dysmennorrhea, menorrhagia or amenorrhea. This has probably a bearing on the susceptibility of women to mental forms of poisoning.

Oliver³ indicates the twofold problem of the pregnant woman in lead work; on the one hand pregnancy seems to predispose to plumbism, and on the other exposure to lead hinders successful delivery.

Lead and progeny

The subject falls under three sub-divisions:

- (a) Progeny of women exposed to lead.
- (b) Progeny of men exposed to lead.
- (c) Type of living progeny where either parent has been exposed to lead.

(a) Progeny of women exposed to lead

Oliver points out that it is not necessary for the mother to have symptoms of lead poisoning for her child to suffer the effects of lead. Both in actual experience of women workers and in animal experiments, it is seen that the offspring of apparently healthy females may be poisoned.

There is general agreement that women who have been exposed to lead are less likely than others to bear and rear their children; but when it comes to collection of evidence, it is seen that this is chiefly derived from England and France, with scattered references from Austria.

1. *England.*

Oliver⁴ quotes figures supplied by a Staffordshire medical officer of health in a report of a departmental committee. These figures, which show the comparison between (1) women exposed to lead and (2) women not exposed to lead, may be recapitulated as follows:

100	mothers in housework	had	43.2	miscarriages and still births.
100	" " millwork (not lead)	had	47.6	" "
100	" " lead work (before marriage)	86.0	" "	" "
100	" " " (after " ")	133.5	" "	" "

Another English instance is also contributed by Oliver⁵ who analyzed the results of 294 pregnancies in 36 women, all of whom have been workers in white

1 Prendergast, British Medical Journal, 1910, Vol. 1, p. 1164.

2 Alice Hamilton, Lead Poisoning in American Industry, J.I.H., May, 1919, p. 18.

3 Oliver, Lead Poisoning, 1914, p. 181.

4 Oliver, British Medical Journal, 1911, Vol. 1, p. 1096.

5 Oliver, Lead Poisoning, 1914, pp. 179, 180.

lead, as follows: 51 miscarriages; 16 still-births; 104 infant deaths shortly after birth; 17 infant deaths within a few years of birth. .

2. *France.*

In a French Government publication of 1905, Tardieu¹ reported that 608 out of 1,000 pregnancies in lead workers resulted in premature birth.

Another Frenchman, M. Paul,² a physician, refers to similar findings: "Of 15 pregnancies of 4 women, who had worked in a type-foundry, 10 ended in abortion, 2 in premature labour, 1 in still-birth, and 1 child died within 24 hours of birth. In another series, 5 women had given birth to 9 children before working in lead without one abortion. After exposure to lead there was a total of 36 pregnancies; of these 26 ended in abortions, 1 in premature labour, 2 in still-births; 5 children died, four of these in the first year of life."

Paul³ again is responsible for the following figures referring to 141 pregnant women who worked in lead factories in France: Of these 82 aborted; 4 had premature births; 5 still-born children. Of the 50 infants born alive, 35 died within 2 years. Thus only 15 children of 141 pregnant women lived beyond the third year.

3. *U.S.A.*

American data is surprisingly scarce, even in view of the fact that women are prohibited from the most dangerous lead work and that owing to economic conditions married women are less apt to remain at work than is the case in the older countries. The cause may lie in the fact that with the exception of Dr. Hamilton, American authorities have investigated women lead workers less than men lead workers. The increasing numbers of women doctors should help to bring the facts to light.

Dr. Hamilton in her investigation into potteries in 1912 stated that miscarriages among the women were "very common," but found it impossible to judge to what extent they were attributable to lead.

(b) *Progeny of men exposed to lead*

1. *England.*

Oliver considers that exposure of the father to lead has an indubitable effect on the likelihood of the child being born and surviving, but quotes only foreign figures in support of his view.

2. *Italy.*

Dr. Carozzi,⁴ of Milan, reports the following results of 3 investigations:

(1) In 455 pregnancies in the wives of type smelters, there were 67 miscarriages, 117 still-births, 277 living births.

(2) In 199 pregnancies of wives of lead miners in Sardinia, there were 55 miscarriages, 108 still births, 36 living births.

(3) In lead colour work the infant death and miscarriage rate with regard to the fathers was 51.6%.

Frogia⁵ also reports a high rate of miscarriages among wives of lead workers.

1 Tardieu, *Poisons Industrielles*, Paris, 1905.

2 Quoted by Oliver, *Lead Poisoning*, 1914, p. 181.

3 Quoted by Gilman Thompson, *The Occupational Diseases*, 1914, p. 256.

4 Quoted by Oliver, *Lead Poisoning*, 1914, p. 183.

5 Quoted by Oliver, *Lead Poisoning*, 1914, p. 184.

3. Germany.

Professor Lewin,¹ of Berlin, reports the experience of 7 women married to lead workers who all had miscarriages, and whose total of 32 pregnancies resulted in only 2 live births.

4. U.S.A.

The evidence is very scarce and somewhat contradictory. Dr. Hamilton² considers that the positive statements of text books to the effect that lead poisoning in the father affects the offspring are too strong for the data given. She, however, cites the following American experimental studies showing that in the lower animals lead poisoning in the male parent affects the nutrition and viability of the offspring. "Cole and Bachhuber,³ working at the Wisconsin Agricultural Station, administered lead acetate to rabbits and fowls. In the case of the rabbits, the mortality of the young during the first days after birth was 47.7% when the father was leaded, as contrasted with 29.2% when the father was normal. The average weight at birth was 49.8 gm. for the former, 59 gm. for the latter.

"C. V. Weller,⁴ of the University of Michigan, used commercial white lead in capsules for feeding guinea pigs. The experiments with leaded males gave very interesting results.

	Free female, Free male	Mated with leaded male
Number of offspring.....	58	65
Average birth weight in grams.....	81.5	66.3
Number stillborn.....	3	3
Died first week.....	2	9

"A normal female was mated alternately with a normal and with a leaded male. The resulting offspring weighed 79 gm. when the male was normal; 54, 47 and 40 gm. when the male was leaded. This underweight was found to persist through life. There was also a high rate of mortality during the first few days after birth. Nine out of sixty-five offspring of leaded males died during the first week, but only 2 out of 105 offspring of normal males."

Hayhurst⁵ provides the chief figures supporting the affirmative view. He refers to a case where of 32 offspring of 7 men suffering from lead poisoning, only 3 lived beyond the third year, 11 being prematurely born, 1 stillborn and the others dying in infancy. In Chicago a group of 33 married painters, 45 years of age or over, were found to have an average of 2.67 born and 1.79 living; 7 had no offspring at all. Hayhurst points out that the men in question were descended from parents who had nearly two and one-half times this number of offspring, and does not consider that social conditions alone could account for the rapid decrease.

Pratt's⁶ figures are not very indicative, since he does not differentiate between poisoning in the father and poisoning in the mother, and further does not state the numbers of children surviving 2 years, but on the whole his findings seem to tell against the theory that lead in the father has bad effect on the offspring. In 109 cases of severe plumbism, 2 of which referred to women, he found that there had been 13 still-born children, 24 infant deaths during the first year and 7 infant deaths during the second year.

¹ Quoted by Oliver, *Lead Poisoning*, 1914, p. 183.

² Alice Hamilton, *Lead Poisoning in American Industry*, J.I.H., May, 1919, p. 18.

³ Cole and Bachhuber, *Prov. Soc. Exper. Biol. & Med.*, 1914, 12, 24.

⁴ C. V. Weller, *Jour. Med. Research*, 1915, N.S. 28, 271.

⁵ Hayhurst, *Industrial Health Hazards and Occupational Diseases in Ohio*, 1915, pp. 379, 380.

⁶ E. E. Pratt, *A Preliminary Report on Lead Poisoning in the City of New York*, New York State Factory Investigating Commission, 1912, Vol. 1, p. 536.

Harris¹ experience also is somewhat contrary to that of England and Europe. He found that the wives of 116 married painters suffering from lead poisoning had had, according to their statements, 340 pregnancies with 70 miscarriages, 13 still births or early deaths, and 257 living children.

(c) **Comparative results on offspring of** (a) **Exposure of the mother to lead and**
(b) **Exposure of the father to lead**

There is difference of opinion as to which has the greatest effect on progeny. Carozzi and Frogia² consider that the influence upon progeny of a father who has been exposed to lead is even greater than that of an expectant woman who had been similarly exposed, and Frogia estimates the infant death and miscarriage rate where the fathers worked in lead as 82% as compared with 44.1% for saturnine mothers.

Oliver states that his experience is against this, and quotes in support of his view the estimate of Rennet "that where the mother alone is exposed to lead the conception is damaged in 92% and in paternal saturnism the damage is 63%."³

Lead poisoning in parents and mentality of children

This question has been little studied and the only reference⁴ found deals with Hungary, where it is reported that in the villages where pottery glazing is the hereditary trade, such offspring of lead-poisoned parents as survive have abnormally large, square heads, associated with a lower mentality.

Recapitulation of evidence on effect of lead on progeny

Leaving aside the question of the *relative* effects on the progeny of (a) the mother's, or (b) the father's exposure, the evidence of the literature available for this study is as follows:

(a) The theory that exposure of the mother to lead produces miscarriages, still-births and infant mortality is generally accepted. It is stated as a fact in almost every comprehensive study of lead, but only rarely are statistics given. The most striking figures are English and French, but the Italian and Austrian experience is confirmatory. American literature contributes little or nothing to the subject, despite the fact that women are employed in many of the lead trades, notably, for instance, the pottery industry.

(b) The theory that exposure of the father to lead produces miscarriages, still-births and infant mortality is generally less confidently stated, but is better substantiated by figures, there being evidence from English, German and Italian authorities and, in one instance, American (Hayhurst). It is further theoretically supported by analogy from American animal experiments so far as infant mortality is concerned.

Qualifications of both (a) and (b) above

Dr. Hamilton⁵ refers to the impossibility of discovering whether the high rate of miscarriages among women in the American potteries is caused by lead

¹ Harris, A Clinical Study of the Frequency of Lead, Turpentine and Benzine Poisoning in 400 Painters, 1918, p. 20.

² Quoted by Oliver, Lead Poisoning, 1914, p. 184.

³ Ibid.

⁴ Chyzer, Chirurgische Presse, Budapest, 1908, Vol. 44, p. 906.

⁵ Alice Hamilton, Lead Poisoning in Potteries, Tile Works and Porcelain Enameled Sanitary Ware Factories, 1912, p. 58.

or is self-induced and therefore an outcome of economic conditions necessitating work after marriage. If this caution against attributing miscarriages to the effects of lead is necessary in the States, it must presumably be more so in England, France and other European countries where poverty is greater and employment of married women more general.

In this connection, however, it must be stated that Oliver quotes the finding by Professor Bedson of lead in the kidney and liver of still-born infants.¹

¹ Quoted by Gilman Thompson, *The Occupational Diseases*, p. 256.

APPENDIX A

SOLUBILITY OF BASIC LEAD SULPHATE AND BASIC LEAD CARBONATE IN HUMAN GASTRIC JUICE AND RELATIVE TOXICITY OF THE TWO SALTS AS SHOWN BY FEEDING EXPERIMENTS WITH DOGS AND CATS

(By A. J. CARLSON and A. WOELFEL, Hull Physiological Laboratory, University of Chicago.)*

"There is no evidence that the lead salts are absorbed from the digestive tract or act locally on the mucosa, except when in solution. The strongest solvent in the digestive tract for lead salts is the hydrochloric acid of the gastric juice, and of less importance the lactic acid, and other organic acids produced in the course of hydrolysis of proteins and of fats, and of bacterial activity. When one considers the humane and economic importance of lead poisoning in the industries, the literature on the action of the gastric juice on the different lead salts appears fragmentary. It was even assumed until less than 10 years ago that lead sulphate was practically insoluble in the stomach and intestines. This view led to the practice, still followed by some doctors, of giving sulphuric acid lemonade to lead workers as a prophylactic measure. Blum,¹ Goadby,² Schicksal,³ and Beck⁴ have studied the solubility of various lead salts in dilute hydrochloric acid, in various artificial gastric digest mixtures, and in gastric juice. All agree that the lead sulphate is soluble in these media. One of Goadby's two experiments with human gastric juice (10 c.c. gastric juice + 0.1 g. of the lead salts, at 37° C. (98.6° F.) for one hour) appears to show that the lead sulphate is even more soluble than is lead carbonate (white lead) or lead oxide (litharge). The second experiment showed practically the same solubility for the three salts. The work of Blum and Schicksal indicates that the presence of peptone in gastric digest mixture increases slightly the solubility of the lead salts.

Relative solubility of lead carbonate and lead sulphate in human gastric juice

Samples of paint dust of "basic lead carbonate" and "basic lead sulphate," respectively, were sent us by Mr. A. M. Johnson, chief chemist of the Pullman Co. Mr. Johnson stated that the samples submitted were typical of the paint dust produced in the Pullman shops by sand-papering painted metal. The dust samples contained, per gram, lead corresponding to the following quantities of lead (determined as sulphate):

	Grams of lead per gram of dust	
Basic lead carbonate paint dust.....	1.04	} average, 1.05 gr.
	1.04	
	1.06	
Basic lead sulphate paint dust.....	.86	} average, .85 gr.
	.87	
	.82	

Samples of sublimed white lead (basic lead sulphate) and of lead carbonate ("Old Dutch Process") not mixed with oil were then tested. On analysis they were found to yield the following quantities of lead determined as sulphate:

	Grams of lead per gram of sample	
Lead carbonate.....	1.12	} average, 1.12 gr.
	1.12	
Basic lead sulphate.....	.98	} average, .97 gr.
	.96	

Normal human gastric juice was obtained from a man 27 years old, with complete constriction of the oesophagus and a gastric fistula of 16 years' standing.

The juice was secreted while the man was chewing palatable food when hungry. Hence it was normal "appetite" or "psychic" juice, not mixed with saliva. The total acidity varied from 0.40 per cent. to 0.52 per cent.

The results are given in Tables I and II. The lead carbonate proved in every case to be much more soluble than the lead sulphate and the lead carbonate paint dust is nearly as soluble as the pure white lead, while the lead sulphate paint dust is less soluble than the pure basic lead sulphate. We are at a loss to account for Goadby's results showing greater solubility of the lead sulphate in gastric juice, except on the ground of faulty methods. A greater solubility of lead sulphate than of lead carbonate in gastric juice seems a chemical impossibility. We note that Goadby records only two tests and the lead was determined after centrifuging the digestive mixture instead of in clear filtrate. It seems probable that varying quantities of the lead salts were present in suspension in addition to that in actual solution.

* Alice Hamilton, *Hygiene of the Painters' Trade*, 1913, pp. 22-32.

1 Blum, *Wiener medizinische Wochenschrift*, 1904, Bd. 54, p. 538; *Deutsche medizinische Wochenschrift*, 1912, Bd. 38, p. 645.

2 Goadby, *Journal of Hygiene*, Cambridge, Eng., University Press, 1909, IX, p. 122.

3 Leymann, *Die Bekämpfung der Bleigefahr in der Industrie*, Jena, 1908.

4 Beck, *Arbeiten aus dem Kais. Gesundheits Amt*, Berlin, 1910. Bd. 34, p. 446.

Peptone in concentration of 0.2 per cent. and 1 per cent. does not have a marked influence on the solubility of the lead salts, but so far as the influence of the peptone is in evidence it may be explained as follows: The formation of lead peptone compounds might lead to the setting free of the chlorine ions in the lead chloride, and thus to the formation of more lead chloride from the carbonate and the sulphate. Our figures show that this is not an important factor in lead poisoning from the digestive tract. (See Summary.)

The solubility of the lead salts in pure gastric juice is practically the same as that in similar quantities of 0.5 per cent. hydrochloric acid. It is therefore clear that the hydrochloric acid of the gastric juice is the all-important solvent. Pepsin, rennin and other organic constituents may combine with the lead salts when in solution, but if this is the case the reaction does not appreciably affect the quantity of lead salts held in solution.

TABLE I.—Relative solubility of Basic Lead Sulphate paint dust and Basic Lead Carbonate paint dust in human gastric juice.

25 c.c. gastric juice + 25 c.c. water + 0.5 g. basic lead sulphate paint dust, at 38° C. (100.4° F.) for 10 hours.		25 c.c. gastric juice + 25 c.c. water + 0.5 g. basic lead carbonate paint dust, at 38° C. (100.4° F.) for 10 hours.	
Experiment Number	Lead Dissolved	Experiment Number	Lead Dissolved
	Grams		Grams
1.....	(a) 0.0396	1.....	(a) 0.1964
	(b) .0276		(b) .2684
2.....	(a) .0582	2.....	(a) .2364
	(b) .0680		(b) .2284
3.....	(a) .0436	3.....	(a) .2264
	(b) .0400		(b) .2262
4.....	(a) .0420		
	(b) .0594		
Average.....	.0473	Average.....	.2304
	=9.5 per cent.		=46.1 per cent.

TABLE II.—Relative Solubility of Lead Carbonate (Old Dutch Process) and Basic Lead Sulphate (Sublimed White Lead) in human gastric juice.

LEAD SULPHATE			LEAD CARBONATE		
Experiment No.	Digestive Mixture	Lead Dissolved	Experiment No.	Digestive Mixture	Lead Dissolved
		Grams			Grams
1.	{ 25 c.c. gastric juice; 25 c.c. water; 0.5 g. lead sulphate at 38° C. (100.4° F.) for 10 hours }	(a) 0.1260 (b) .1210	1.	{ 25 c.c. gastric juice; 25 c.c. water; 0.5 g. lead carbonate at 38° C. (100.4° F.) for 10 hours. }	(a) 0.2940 (b) .3044
2.	{ 25 c.c. gastric juice; 25 c.c. water; 0.5 g. lead sulphate; 0.1 g. peptone (a), 0.5 g. pep- tone (b), at 38° C. (100.4° F.) for 10 hours. }	(a) .1376 (b) .1284	2.	{ 25 c.c. gastric juice; 25 c.c. water; 0.5 g. lead carbonate; 0.1 g. peptone (a), 0.5 g. pep- tone (b), at 38° C. (100.4° F.) for 10 hours. }	(a) .3302 (b) .3100
3.	{ 50 c.c. gastric juice; 0.5 g. lead sulphate, at 38° C. (100.4° F.) for 10 hours. }	.1500	3.	{ 50 c.c. gastric juice; 0.5 g. lead carbonate, at 38° C. (100.4° F.) for 10 hours. }	.3896
		Grams Per cent.			Grams Per cent.
Average.....		{ (1) 0.1235 = 24.7 (2) .1330 = 26.6 (3) .1500 = 30.0 }	Average.....		{ (1) 0.2992 = 59.8 (2) .3201 = 64.0 (3) .3896 = 77.9 }

It can be seen, therefore, that the lead carbonate is a little more than twice as soluble as the sulphate.

Relative toxicity of lead sulphate and lead carbonate when fed to dogs and cats

Since it is not possible in experiments *in vitro*, even when normal gastric juice is available, to reproduce some of the essential conditions of gastric digestion, the final solution of the question of the relative toxicity of the different lead salts must be sought by feeding experiments. Goadby fed various lead salts to cats. Five cats received from 0.5 to 0.8 grams dry white lead (lead carbonate) per day for periods varying from 1 to 18 months. According to Goadby, this quantity of lead carbonate per day produced practically no symptoms unless alcohol was given at the same time. One must infer from Goadby's work that cats are unusually resistant to lead salts given by mouth. In an earlier work Lehmann¹ showed, however, that even the slightly soluble lead sulphate produces toxic symptoms in eight or nine days when fed to cats in quantities of 0.2 grams per day. Blum² concludes that the sulphate is less toxic than the other lead salts employed in the industries.

FEEDING EXPERIMENTS, SERIES I.

Dogs of nearly the same size and age were selected, and 4 grams of the lead sulphate and the lead carbonate paint dust respectively were fed to the dogs in ground meat, either in one feeding or in two feedings, eight hours apart. The results are summarized in Table III.

The faeces of dogs A and B (Table III) were collected for six days after giving the lead paint dust per mouth, and the quantity of lead determined, with the following result:

Dog B, fed 4 grams basic lead carbonate, containing 4.16 (*sic*) grams lead determined as sulphate. Lead recovered in the faeces, 2.61 grams, or 63 per cent.

Dog A, fed 4 grams basic lead sulphate, containing 3.28 grams lead determined as sulphate. Lead recovered in faeces, 3.10 grams, or 95 per cent.

The lead in the faeces of dogs C and D was not determined.

TABLE III.—Effects of 4 grams of lead sulphate and of lead carbonate paint dust when fed to dogs in one and two feedings.

Day	Dog A: Weight, 10K (22 lbs.)	Dog B: Weight, 11K (24.3 lbs.)
First.....	2.0 g. basic lead sulphate paint dust in meat at 8 a.m. and 4 p.m.	2.0 g. basic lead carbonate paint dust in meat at 8 a.m. and 4 p.m.
Second.....	Dog normal.....	Vomiting; great thirst; polyuria; depression; some tremors; no appetite.
Third.....	Dog normal.....	Condition same as on second day.
Fourth.....	Dog normal.....	Eats a little; drinks and vomits frequently.
Fifth.....	Dog normal.....	Condition about same as on fourth day.
Sixth.....	Dog normal.....	Considerably improved; eats; does not vomit, but seems depressed.
Seventh.....	Dog normal.....	Dog seems fairly normal.
	Dog C: Weight, 7K (15.4 lbs.)	Dog D: Weight, 6.5 K. (14.3 lbs.)
	4.0 g. basic sulphate paint dust in meat at one feeding. Dog developed some constipation, but no other symptoms of lead poisoning.	4.0 g. basic lead carbonate paint dust in meat at one feeding. Dog ran practically the same course of acute lead poisoning as dog B, with final complete recovery.

FEEDING EXPERIMENTS, SERIES II.

Eight hearty dogs were selected for this test, and grouped in pairs of approximately the same body weight. One of the dogs of each pair was fed the sulphate paint dust in meat, the other

¹ Lehmann, Archiv. fur Hygiene, München und Leipzig, 1892, Bd. 16, p. 316.

² Blum, Deutsche medizinische Wochenschrift, Leipzig und Berlin, 1912, Bd. 38, p. 645.

one given the carbonate paint dust in meat. The quantity of the lead paint dusts given each dog was fixed to equal 0.1 gram lead sulphate per kilo (2.2046 pounds) body weight. The dogs fed the sulphate paint dust thus received a greater quantity of the dust, as this dust contained a lower percentage of lead than the carbonate paint dust.

The results are summarized in Table IV. The table shows that the dogs receiving the lead carbonate paint dust developed severe symptoms of acute lead poisoning within 24 to 48 hours after the first feeding, while the dogs fed the sulphate paint dust showed very mild symptoms of lead intoxication only after three or four feedings—that is, after 72 to 96 hours. Feeding experiments as tests of relative toxicity break down, of course, as soon as vomiting or lack of appetite appears, as one cannot control the quantity of lead salts eaten or retained. For that reason the experiment was discontinued as soon as there appeared symptoms of intoxication in the dogs receiving the least toxic lead salt—that is, the sulphate.

FEEDING EXPERIMENTS, SERIES III.

The results of the feeding tests with the sulphate and the carbonate of lead do not agree with those of Goadby on cats. It does not seem likely that cats have so much greater tolerance than dogs to lead salts per os. Legge and Goadby claim, indeed, that cats are especially susceptible to lead poisoning. Moreover, Leymann obtained symptoms in cats from feeding 0.2 gram lead sulphate per day for 8 to 9 days. How are Leymann's results on cats and our result on dogs to be reconciled with Goadby's failing to produce lead poisoning in cats on feeding the more toxic lead carbonate in daily doses up to 0.8 gram for 2 to 18 months? It is difficult to understand where any material source of error might be concealed in the relatively simple process of mixing lead salts with the food, and observing the animals.

Our own test series consisted of four healthy cats, which we may designate as A, B, C and D. The quantity of the lead salts mixed with the food each day was fixed to equal 0.1 gram lead sulphate per kilo (2.2046 pounds) body weight of cat. The amount of ground meat, fish, or milk and bread with which the lead salts were mixed was less than each cat would ordinarily eat each day, so as to insure all of the lead salts reaching the stomach.

CAT A.—Fed 0.3 gram lead carbonate per day. The first three days the cat did not touch the food, although a new lot was prepared each morning. On the fourth day the cat ate about four-fifths of the food. No symptoms were observed, but the cat did not touch the food for two days following. On the seventh to the eleventh days the cat ate about one-fourth of the food each day. No obvious symptoms of lead poisoning.

CAT B.—Fed 0.37 gram lead sulphate per day. Cat refused the food-lead mixture the first three days. The fourth day the cat ate all the food, on the sixth to the eighth day about one-third of the food. On the ninth day all the food was consumed, but on the two following days less than half of it was taken. No lead intoxication in evidence.

CAT C.—Fed 0.31 gram basic lead carbonate paint dust per day. First day cat ate about three-fourths of the food-lead mixture; second day cat ate about one-half of the mixture. On the morning of the third day the cat had vomited a considerable mass of partly digested meat. The cat seemed depressed during the third to the eighth days and refused all food. During the ninth to the eleventh days the cat ate about one-fourth of the food each day. There were no further symptoms.

CAT D.—Fed 0.3 gram basic lead sulphate paint dust per day. The cat did not touch the food-lead mixture during the first three days. On the remaining 8 days of the feeding period the cat ate all the food on 4 days, and on the other days about one-third of the food. No symptoms of lead poisoning appeared at any time.

This 11 day feeding period convinced us of one thing only, that mixing the lead salts with the food is not a feasible method in the case of cats. The addition of small quantities of lead salts to the ground meat, fish, or milk and bread renders the food mass so unpalatable through taste or odor that the cats will starve for days rather than eat, and one cannot be certain of the cat eating even a small portion of the food on any day. In the test of the relative toxicity of the two salts it is, of course, essential that all of the salts given shall reach the stomach each day. The method of mixing the lead salts with the food was therefore abandoned. A second series of four cats was selected and 0.1 gram of the lead salts per kilo (2.2046 pounds) body weight administered in gelatin capsules each morning before giving the customary food. The results are given in Table V.

The cats varied in weight from 2.5 to 3.5 kilos (5.5 to 7.7 pounds). Hence 0.25 gram constituted the smallest and 0.35 gram the largest dose of lead salts given per day. Toxic symptoms were produced by all the salts, but the lead carbonate and the lead carbonate paint dust were distinctly more toxic than the basic lead sulphate and the lead sulphate paint dust. The toxic symptoms noted were vomiting, loss of appetite, constipation, and depression. The feeding period was too short for the development of the chronic nervous symptoms.

It will thus be seen that cats and dogs show about the same susceptibility to the lead intoxication per os. Lead carbonate and lead sulphate when given daily in quantities up to 0.1 gram per kilo (2.2046 pounds) body weight produce toxic symptoms within 2 to 8 days.

TABLE IV.—Effects of daily feedings of lead sulphate and lead carbonate paint dusts to dogs in quantities of 0.1 gram per kilo (2.2046 pounds) body weight.

	BASIC LEAD SULPHATE PAINT DUST					BASIC LEAD CARBONATE PAINT DUST				
Day	Dog A: Weight, 6.8 K. (15 lbs.)	Dog C: Weight, 12.5 K. (27.6 lbs.)	Dog E: Weight, 10.2 K. (22.5 lbs.)	Dog G: Weight, 12.3 K. (27.1 lbs.)	Dog B: Weight, 7.0 K. (15.4 lbs.)	Dog D: Weight, 13.4 K. (29.5 lbs.)	Dog F: Weight, 10.3 K. (22.7 lbs.)	Dog H: Weight, 14.2 K. (31.3 lbs.)		
First.....	Normal.	Normal.	Normal.	Normal.	Normal.	Normal.	Normal.	Normal.		
Second.....	Normal.	Normal.	Normal.	Normal.	Severe diarrhea; vomiting; eats a little.	Diarrhea; faces bloody; great thirst; vomits; eats a little.	Slight diarrhea; wise normal; eats well.	Seems normal.		
Third.....	Normal.	Normal.	Seems normal, but does not eat as much as usual.	Normal.	Diarrhea; depression, vomiting; eats a little.	Diarrhea; vomiting; does not eat.	Diarrhea; vomiting; eats a little.	Depression; some tremors; vomiting; eats a little.		
Fourth.....	Some depression; eats less than normally.	Normal.	Some depression; eats less than normally.	Had vomited during night; eats eagerly.	Diarrhea; does not eat; great thirst.	Condition fair; does not eat.	Diarrhea; vomiting; eats a little.	Diarrhea; vomiting; does not eat.		
Fifth.....	Refuses food; otherwise in good condition; weight, 6.9 K. (15.2 lbs.)	Slight depression; vomiting; weight, 11.9 K. (26.2 lbs.)	Slight depression; weight, 9.8 K. (21.6 lbs.)	Slight depression; eats less than normally; weight, 12.4 K. (27.3 lbs.)	Condition fair; eats a little; weight, 6.6 K. (14.6 lbs.)	Condition fair; eats a little; weight, 12.8 K. (28.2 lbs.)	Diarrhea; vomiting; does not eat; weight, 9.9 K. (21.8 lbs.)	Diarrhea; depression;; eats a little weight, 13.1 K. (28.9 lbs.)		

TABLE V.—Effects of feeding to cats 0.1 gram of the respective lead salts per kilo (2.2046 pounds) body weight every morning before being given their usual food.

Feeding day	CAT I: Fed lead carbonate	CAT II: Fed lead sulphate	CAT III: Fed lead carbonate paint dust	CAT IV: Fed lead sulphate paint dust
First.....	Normal.....	Normal.....	Normal.....	Normal.
Second....	Vomited.....	Normal.....	Normal.....	Normal.
Third.....	Did not eat.....	Normal.....	Vomited.....	Normal.
Fourth.....	Did not eat.....	Vomited.....	Normal.....	Normal.
Fifth.....	Eats a little; depressed.	Seems normal.....	Vomited.....	Normal.
Sixth.....	Eats a little; depressed.	Seems normal.....	Did not eat.....	Normal.
Seventh....	Vomited.....	Seems normal.....	Did not eat.....	Normal.
Eighth.....	Did not eat.....	Seems normal.....	Eats a little.....	Eats a little.
Ninth.....	Did not eat.....	Vomited.....	Eats a little.....	Did not eat.
Tenth.....	Did not eat; greatly depressed. ¹	Eats a little; depressed.	Eats a little; greatly depressed.	Eats a little.

1 This cat developed ataxia, paralysis, and opisthotonos on the twelfth day.

TABLE VI.—Influence of Milk on the Solubility of Lead Salts in Human Gastric Juice and in 0.5 per cent. Hydrochloric Acid.

LEAD SULPHATE			LEAD CARBONATE		
Experiment No.	Digestive mixture	Lead dissolved	Experiment No.	Digestive mixture	Lead dissolved
1.	25 c.c. gastric juice; 25 c.c. milk; 0.5 g. lead sulphate paint dust at 38°C. (100.4° F.) for 10 hours.	(a) None. (b) None.	1.	25 c.c. gastric juice; 25 c.c. milk; 0.5 g. lead carbonate paint dust at 38°C. (100.4° F.) for 10 hours.	(a) Trace. (b) Trace.
2.	25 c.c. gastric juice; 25 c.c. milk; 0.5 g. lead sulphate paint dust at 38°C. (100.4° F.) for 10 hours.	(a) None. (b) None.	2.	25 c.c. gastric juice; 25 c.c. milk; 0.5 g. lead carbonate paint dust at 38°C. (100.4° F.) for 10 hours.	(a) None. (b) None.
3.	25 c.c. gastric juice; 25 c.c. milk; 0.5 g. lead sulphate paint dust at 38°C. (100.4° F.) for 10 hours.	(a) None. (b) None.	3.	25 c.c. gastric juice; 25 c.c. milk; 0.5 g. lead carbonate paint dust at 38°C. (100.4° F.) for 10 hours.	(a) Trace. (b) Trace.
4.	25 c.c. 0.5 per cent. HCl; 0.5 g. lead sulphate paint dust at 38° C. (100.4° F.) for 10 hours.	(a) 0.0578 g. (b) .0562 g.	4.	25 c.c. 0.5 per cent. HCl; 0.5 g. lead carbonate paint dust at 38° C. (100.4° F.) for 10 hours.	(a) 0.3284 g. (b) .3344 g.
5.	25 c.c. 0.5 per cent. HCl; 25 c.c. milk; 0.5 g. lead sulphate paint dust at 38° C. (100.4° F.) for 10 hours.	(a) None. (b) None.	5.	25 c.c. 0.5 per cent. HCl; 25 c.c. milk; 0.5 g. lead carbonate paint dust at 38° C. (100.4° F.) for 10 hours.	(a) None. (b) None.
6.	50 c.c. 0.5 per cent. HCl; 25 c.c. milk; 0.5 g. lead sulphate paint dust at 38° C. (100.4° F.) for 10 hours.	(a) 0.0126 g. (b) .0132 g.	6.	50 c.c. 0.5 per cent. HCl; 25 c.c. milk; 0.5 g. lead carbonate paint dust at 38° C. (100.4° F.) for 10 hours.	(a) 0.1320 g. (b) .1218 g.

TABLE VI.—Continued.

LEAD SULPHATE			LEAD CARBONATE		
Experi- ment No.	Digestive mixture	Lead dissolved	Experi- ment No.	Digestive Mixture	Lead dissolved
7.	100 c.c. 0.5 per cent. HCl; 25 c.c. milk; 0.5 g. lead sulphate paint dust at 38° C. (100.4° F.) for 10 hours.	(a) 0.0590 g. (b) .0580 g.	7.	100 c.c. 0.5 per cent. HCl; 25 c.c. milk; 0.5 g. lead carbonate paint dust at 38° C. (100.4° F.) for 10 hours.	(a) 0.4010 g. (b) .4340 g.
8.	100 c.c. gastric juice; 25 c.c. milk; 0.5 g. lead sulphate at 38° C. (100.4° F.) for 10 hours.	0.1740 g.	8.	100 c.c. gastric juice; 25 c.c. milk; 0.5 g. lead carbonate at 38° C. (100.4° F.) for 10 hours.	0.4900 g.

Retarding Effect of Milk on the Solubility of Lead Salts in Human Gastric Juice.

We were especially interested in the action of milk on the solubility of the lead salts in human gastric juice and weak solutions of hydrochloric acid in view of the fact that in some places lead workers are required to drink milk before starting to work. And practical experience seems to show that milk or other food in the stomach minimizes the danger of lead poisoning from the digestive tract. When milk and gastric juice are mixed in the proportion of 1 to 1, lead salts added, and the mixture incubated at body temperature for 10 hours, not enough lead goes into solution even to get a qualitative lead test. Only when the lead carbonate paint dust was used, in two cases a positive qualitative test was obtained. The same results are obtained in mixtures of milk and 0.05 per cent. hydrochloric acid. But when the ratio of the gastric juice or the hydrochloric acid to the milk is increased, the lead salts are dissolved in proportion to the increase in the quantity of the gastric juice or hydrochloric acid.

The above action of milk is probably due to the fixation of the hydrochloric acid by the milk protein and the neutralization of the hydrochloric acid by the carbonate of milk. Hence when an excess of milk is added to the gastric juice there will be no hydrochloric acid to effect solution of the lead salts, while in the presence of an excess of gastric juice some free hydrochloric acid remains to act on the lead. We are inclined to the view that the formation of insoluble lead albuminates is a factor of minor importance in the above action of milk.

These experiments in vitro do not reproduce some of the conditions that obtain in normal gastric digestion. The fixation of the hydrochloric acid by the proteins takes place in the stomach as well as in the test tube, so that the presence of proteins retards the appearance of free hydrochloric acid in the contents of the stomach. But the work of Cannon and others renders it highly probable that relaxation of the pyloric sphincter and entrance of the gastric content into the duodenum is ordinarily preceded by the development of some free hydrochloric acid in the pyloric portion of the stomach. This hydrochloric acid will, of course, tend to dissolve any lead salts in the chyme until it is neutralized in the duodenum. Albuminous foodstuffs can therefore diminish the solution of lead salts in the stomach only to the extent that they fix the hydrochloric acid in the gastric juice.

The taking of milk is a more efficient prophylactic measure than the taking of an equal amount of other forms of proteins, because there is less appetite secretion of gastric juice with milk, and the fat in the milk depresses and retards the action of the gastric secretagogues.

Summary of conclusions on solubility and feeding experiments

1. SOLUBILITY OF WHITE LEAD IN HUMAN GASTRIC JUICE.

White Lead Paint Dust:	Per cent.
Soluble in pure gastric juice (25 c.c. gastric juice, 0.5 g. dust):	
Basic lead carbonate paint dust.....	46.1
Basic lead sulphate paint dust.....	9.5
Soluble in gastric juice and peptone (25 c.c. gastric juice, 0.1 g. peptone, 0.5 g. dust):	
Basic lead carbonate paint dust.....	46.0
Basic lead sulphate paint dust.....	7.3

	Per cent.
Soluble in gastric juice and milk (gastric juice 1, milk 1):	
Basic lead carbonate paint dust.....	None
Basic lead sulphate paint dust.....	None
Soluble in 0.5 per cent. HCl (25 c.c. HCl, 0.5 g. dust):	
Basic lead carbonate paint dust.....	66.3
Basic lead sulphate paint dust.....	11.4
Soluble in 0.5 per cent. HCl and milk (HCl 1, milk 1):	
Basic lead carbonate paint dust.....	None
Basic lead sulphate paint dust.....	None
Soluble in 0.5 per cent. HCl and milk (HCl 2, milk 1):	
Basic lead carbonate paint dust.....	25.4
Basic lead sulphate paint dust.....	2.6
Soluble in 0.5 per cent. HCl and milk (HCl 4, milk 1):	
Basic lead carbonate paint dust.....	83.5
Basic lead sulphate paint dust.....	11.7

White Lead:

Soluble in pure gastric juice (25 c.c. gastric juice, 0.5 g. lead):	
Lead carbonate (old Dutch process).....	59.8
Basic lead sulphate.....	24.7
Soluble in gastric juice and peptone (25 c.c. gastric juice, 0.5 g. lead):	
Lead carbonate (old Dutch process).....	64.0
Basic lead sulphate.....	26.6
Soluble in pure gastric juice (50 c.c. gastric juice, 0.5 g. lead):	
Lead carbonate (old Dutch process).....	77.9
Basic lead sulphate.....	30.0
Soluble in gastric juice and milk (gastric juice 4, milk 1):	
Lead carbonate.....	98.0
Lead sulphate.....	34.8

2. TOXICITY OF LEAD WHEN FED TO DOGS AND CATS.

The lead carbonate is much more toxic than the lead sulphate, but both salts produce acute lead poisoning when given in quantities of 0.1 g. per kilo body weight per day.

3. THE INFLUENCE OF MILK.

When milk and gastric juice are mixed in the proportion of 1 to 1, the hydrochloric acid of the gastric juice is so completely fixed by the milk proteins or neutralized by the carbonates in the milk that the mixture has virtually no solvent action on the lead salts. But when the gastric juice is present in excess of the milk, the lead salts go into solution in proportion to the excess of gastric juice. When milk is taken into the stomach there occurs, of course, a similar fixation of the hydrochloric acid, and, in addition, the total quantity of gastric juice is diminished owing to the inhibitory action of the fat of the milk on the processes of secretion.

4. THREE PRACTICAL SUGGESTIONS.

On the basis of our work, we venture to offer these three practical suggestions:

(a) The lead carbonate is so much more toxic than the lead sulphate that the lead workers as well as the State should aim at the elimination of the use of the carbonate in all industries where this is possible.

(b) Basic lead sulphate, or sublimed lead, is poisonous and none of the precautions usually advocated for the protection of workers in lead should be neglected by those handling lead sulphate.

(c) In addition to taking other important prophylactic measures, workers in lead salts should drink a glass of milk between meals (say at 10 a.m. and 4 p.m.) in order to diminish the chances that the lead they have swallowed be dissolved by the free hydrochloric acid of the gastric juice, as in some persons there is considerable secretion of gastric juice in the empty stomach."

APPENDIX B

THE SOLUBILITY OF LEAD SULPHIDE ORES AND OF LEAD SULPHIDE IN HUMAN GASTRIC JUICE*

By A. WOELFEL and A. J. CARLSON, Department of Physiology,
University of Chicago.

"The following tests of the solubility of lead sulphide ore dust in human gastric juice were made at the request of Dr. Alice Hamilton, special investigator of occupational lead poisoning for the United States Bureau of Labour Statistics, who reported to us that she had found some 25 cases of lead poisoning among men employed in mines and concentrating mills in southeastern Missouri. The mines in this region are supposed to yield practically pure galena.

The literature on industrial plumbism usually takes for granted the nonpoisonousness of lead sulphide in the animal body, though the experimental data on which this belief is founded are both meagre and conflicting. Blum¹ who is the most widely quoted authority on the subject, found that he could feed animals large quantities of lead sulphide without apparently producing any injurious effects. Leymann² says that the sulphide is the compound found in most of the ore smelted in Germany, and experience shows that it does not give rise to lead poisoning in workmen—experience which is confirmed by tests on animals. If there is any danger at all in the handling of these ores it is so slight as to be practically negligible.

Rambousek³ at the International Congress of Industrial Hygiene, which was held at Milan in 1906, quoted the work of Leymann and of Blum and confirmed their opinion as to the nonpoisonous nature of lead sulphide, which he fed to animals in large doses without producing any ill effects. He found also that artificial gastric juice (0.1 per cent. HCl with or without about 1 per cent. of peptone) had no effect whatever on lead sulphide. Biondi⁴ opposed this assertion and claimed to have seen among the galena miners of Sardinia many men who showed the usual signs of lead absorption. While severe colic or neuritis is extremely rare among these men, that is explained by improved hygienic regulations in the mines, since in former years such phenomena were common enough. On the other hand, Rambousek cited the statistics of the galena mines of Příbram, in Bohemia, where among 10,000 miners there was not one case of lead poisoning, while among the 4,000 smelters there were 150 cases.

Experimental evidence of the solubility of lead sulphide in the animal body seems to have been furnished first by Murgia,⁵ who, after feeding dogs and rabbits with blende (zinc sulphide) which contained lead sulphide in the proportion of 0.2 per cent., found traces of lead in both liver and intestines. Recently Brezina and Eugling⁶ undertook to study chronic plumbism in animals, basing their conclusions as to lead absorption on the appearance of basophilic granules in the red blood corpuscles of the animals in question.

The lead compounds were introduced into subcutaneous pockets, were rubbed into the shaved skin with lanoline ointment, and finally were mixed with the food. The animals selected were guinea pigs. The characteristic stippling of the cells appeared in the animals treated with lead sulphide more quickly and in larger numbers than in those which were treated with lead sulphate.

The general plan of the present series of tests is the same as that followed in our previous tests with white lead (Carlson and Woelfel, Bulletin of the United States Bureau of Labour Statistics, No. 120, p. 22 et seq.) with the exception of feeding experiments on animals. The gastric juice was obtained from Mr. V., our man with the permanent gastric fistula. The juice was collected while Mr. V. was chewing palatable food when hungry. It was therefore the so-called appetite gastric juice, ranging in free acidity from 0.43 to 0.48 per cent. The collection of the gastric juice was extended over several days, the different lots being mixed, so that all the tests on the various ores were made with the same stock of human gastric juice.

Samples of lead sulphide ores were kindly sent us by the Federal Lead Company, of Federal, Illinois, and by the St. Joseph Lead Company, of Herculaneum, Missouri. The Federal Lead Company sent one sample from the Federal concentrator at Flat River, and one sample from the Desloge concentrator; both samples were pulverized. The ore sample from the St. Joseph Lead Company, which has its concentrator at Bonne Terre, was not pulverized when received.

* Alice Hamilton, *Lead Poisoning in the Smelting and Refining of Lead*, 1914, pp. 82-84.

1 F. Blum, *Über das Schicksal des Blei im Organismus*. Wiener Medizinische Wochenschrift, 1904, vol. 54, pp. 538-543.

2 Leymann, *Bekämpfung der Bleigefahr in der Industrie*, Jena, 1908, p. 4.

3 Rambousek, *Transactions 1st International Congress for Industrial Diseases*, Milan, 1906, pp. 609-617; also Il Ramazzini, 1907, pp. 472-473.

4 Biondi, *Transactions 1st International Congress for Industrial Diseases*, Milan, 1906, pp. 293-308; Il Ramazzini, 474-479.

5 Murgia, *Clinica Moderna*, 1906, No. 27, p. 316.

6 E. Brezina and M. Eugling, *Untersuchungen über experimentelle chronische Bleivergiftung*. Wiener Arbeiten aus dem Gebiete der Sozialen Medizin, II Heft, 1912, vol. 5, pp. 29-34.

According to the statements kindly furnished us by the two companies these ore samples assayed the following percentages of lead:

Federal Lead Company:	Per cent. of lead
Sample from the Federal concentrator.....	73.4
Sample from the Desloge concentrator.....	70.1
St. Joseph Lead Company:	
Sample of ore from Bonne Terre.....	72.0

Parallel tests were run with lead sulphide such as is furnished to chemical laboratories, This turned out not to be absolutely pure lead sulphide, however, as the human gastric juice brought, into solution a trace of iron besides the lead. All the ore samples contained a good deal of iron some of which was dissolved by the gastric juice together with the lead. The iron was, of course, not included in figuring the percentage of the lead sulphide dissolved by the gastric juice.

In order to render the tests directly comparable with the previous tests on white lead we used the following quantities: Lead sulphide ore, 0.5 g.; human gastric juice, 25 c.c.; distilled water, 25 c.c. at 38° C. (100° F.) for 10 hours.

The results are given in the following table:

TESTS AS TO SOLUBILITY IN HUMAN GASTRIC JUICE OF LEAD SULPHIDE ORE FURNISHED BY VARIOUS ESTABLISHMENTS.

(Solvent used, 25 c.c. human gastric juice and 25 c.c. distilled water at 38 C. (100° F.) for 10 hours.)

	Amount of lead sulphide ore used for digestion	Lead contained in ore	Lead sulphate derived from digestion	Lead contained in lead sulphate	Average percentage of lead dissolved
	Gram	Gram	Gram	Gram	
Federal concentrator..... 1	0.5	0.367	0.0164	0.0111	} 2.94
2	.5	.367	.0156	.0106	
3	.5	.367	.0158	.0107	
Desloge concentrator..... 1	.5	.350	.0072	.0049	} 1.38
2	.5	.350	.0076	.0051	
3	.5	.350	.0066	.0045	
St. Joseph Lead Co..... 1	.5	.360	.0172	.0117	} 3.32
2	.5	.360	.0178	.0121	
3	.5	.360	.0176	.0120	
Laboratory lead sulphide..... 1	.5	.433	.027	.0185	} 4.60
2	.5	.433	.029	.0197	
3	.5	.433	.032	.0218	

1 Calculated on the basis of the material being pure lead sulphide, containing 86.5 per cent. lead.

Pure lead sulphide and the dust of lead sulphide ores are soluble in human gastric juice at body temperature. Lead sulphide ore dust is therefore soluble in the human stomach, somewhat less so than basic lead sulphate, very much less so than basic lead carbonate. In our tests with the sulphate and the carbonate, using the same quantity of gastric juice, the solubility of the lead sulphate amounted to 9.5 per cent.; that of the carbonate to 46 per cent. The table shows that the solubility of lead sulphide ore averages about 2.5 per cent., while the solubility of laboratory lead sulphide is higher. We cannot account for the distinctly lower solubility of the ore dust from the Desloge concentrator.

Summary

1. Lead sulphide is soluble in human gastric juice.
2. The solubility of lead sulphide is less than that of basic lead sulphate or basic lead carbonate, but the sulphide is sufficiently soluble to be dangerous to the health of persons engaged in mining and milling lead sulphide ore, if the mining and milling processes involve the production of dust.
3. The persons engaged in mining and milling lead sulphide ore should therefore be protected in the same way as workers in other dangerous lead industries."

CHAPTER II

PATHOLOGY OF LEAD POISONING

Circulatory system

(a) The blood

One of the first systems of the body to be attacked by lead is the circulatory system. In chronic poisoning, facial pallor attracts early attention. Yet with well-marked facial pallor, there may be a normal hæmoglobin content and a normal blood cell count. Also the conjunctival and the mucous membranes may remain a good colour. But there is soon found a distinct reduction in the number of red blood corpuscles and a corresponding fall in hæmoglobin. Occasionally there is found a change in the white blood cells approaching polymorphonucleosis, lymphocytosis or mononucleosis, but usually there is no marked alteration in structure or in number. A structural change in the red blood corpuscles which appears in many cases of early lead poisoning has led to a great deal of argument; this change, the production of basophil granules, is believed to be due to regenerative changes in the nucleus, or simply to the passing into the blood stream of recently formed elements. It is found in other conditions and other kinds of poisoning. Basophilia, if present, does not seem to bear a definite relationship to the amount of hæmoglobin.

Glibert¹ found the elasticity of the red blood corpuscles strikingly reduced, the viscosity of the blood increased and the coagulation time markedly increased. Rambousek² found the power of resistance of the corpuscles to chemically acting hæmolytic agents, such as decinormal soda solution, considerably reduced.

(b) The blood vessels

After the blood, the blood vessels are the most likely organs to be attacked and undergo changes. In chronic lead poisoning the pulse is usually hard and of high tension. This is especially noted during an attack of colic, but not invariably. Drugs having a vaso-dilator action have a distinctly calming effect on the pain during colic. "Cramps" of the blood vessels have been observed. Definite cerebral anæmia due to vasoconstriction has been found in dogs poisoned by lead. In the case of lead amaurosis associated with lead colic, Elschnig³ considers that the action of lead acts directly on the unstriped muscular fibre of the vessel wall. Common lesions of lead poisoning known for a long time are arteriosclerosis and arteritis, even to the obliterative type. The arteriosclerosis may be accompanied by an elevated blood pressure.

(c) The heart

Apparently the heart is affected very little directly, but through the action of lead on the blood vessels, resulting in hypertrophy.

Gastro-intestinal system

After the pallor, the blue line on the gums will frequently be found on examination of lead poisoning. This blue line is due to the formation and deposit of lead sulphide by the action of hydrogen sulphide arising from decomposition

¹ Glibert, *La Saturnisme Expérimental: Extraits des Rapports Ann. de l'Insp. du Travail*, 1906. Rambousek, *Industrial Poisoning*, Translated by Legge, 1913, p. 178.

² Rambousek, *Industrial Poisoning*, Translated by Legge, 1913, p. 178.

³ Elschnig, *Wien. Med. Woch.*, 1898.

in the mouth or by the sulphur of the potassium sulphocyanide present in the saliva. The lead has been dissolved in the saliva or has been brought by the blood stream to the gums, or is held as fine particles by the phagocytic cells of the blood.

Devoto¹ has found a preceding hyperchlorhydria in some cases and in others a chronic gastric catarrh favouring the absorption of lead when swallowed. Gastritis and enteritis have been observed in chronic poisoning. Where a lead salt such as the acetate has been swallowed, there is a caustic action on the gastric mucous membrane.

In the intestines of patients who have died of lead poisoning and in animals under experimental plumbism, Oliver² has found bluish-black patches in the mucous membrane, due to the deposit of lead sulphide. Considerable amounts of lead were found in the large intestine. This may be unabsorbed lead or lead re-excreted into the intestine.

In experimental plumbism Oliver² has found the intestinal canal in places so constricted by muscular spasm as to have the calibre completely obliterated. Riegels³ found in every instance of colic evidence that lead had produced a toxic vasoconstriction of the splanchnic vessels through the stimulation of the vasoconstrictor nerves.

The causes of colic are attributed to either arterial constriction, irritation of solar plexus, or irregular constrictions of the intestinal canal.

Oliver² has found lead in the liver at autopsy. The liver cells may be found atrophied, may have undergone fatty degeneration, or there may be an increase of the interstitial tissue resembling a mild cirrhosis; it may be intercellular or interlobular. Fatty infiltration was found in one case.

Excretory System

Lead has been found in the kidneys at autopsy. Small amounts are excreted in the urine in many cases. Yet no lead has been found in the urine of some cases of undoubted poisoning with lead. The lead excretion may be a source of extra stress on the kidney. Urobilin in increased amounts, hæmatoporphyrin and temporary albuminuria have occurred with each successive attack of colic. The last may disappear after an attack of colic, but in many cases it persists and is accompanied by changes in the blood vessels. The urine is scanty during an attack of colic. Albuminuria may be met with much earlier than kidney structural change. Blood is rarely, if ever, met with in the urine of chronic plumbism cases.

The structural changes in the kidney are most marked. The contracted kidney is the most common pathological event in chronic plumbism. It is usually accompanied by widespread thickening of the small arteries. In chronic plumbism Oliver² has found there may be atrophy of the connective tissue and glomeruli with hyaline degeneration of the vessels. In general, the lesions are those of chronic interstitial nephritis, but where a lead worker dies from acute plumbism after only a few weeks or months in a factory, there may be acute parenchymatous nephritis. In the latter case the cells are swollen; there is cloudy swelling or fatty degeneration. The cells break down and fill the tubules with debris. Inside the glomeruli there may be evidence of cellular proliferation, while leucocytes may be gathered around the afferent vessels.

¹ Devoto, *Le alterazioni dei vasci, dei reni e delle articolazioni nel saturnismo cronico*, 1911.

² Oliver, *Lead Poisoning*, 1914.

³ Riegels, *Koberts Lehrbuch der Intoxikationen*, p. 363.

Devoto¹ believes that the elimination of lead causes vasoconstriction with functional retardation, resulting in augmented uric acid blood content. In time a chronic indurative nephritis develops with moderate albuminuria and arteriosclerosis. In some cases the uricæmia results in gout.

Rambousek² mentions lead gout and lead nephritis as later symptoms of lead poisoning. It seems to be proved that the gout is true gout with tophi present and that the contracted kidney is indistinguishable from ordinary chronic Bright's disease.

The histological changes in the kidney resemble strongly those due to the effects of alcohol, and this may be the cause in some lead workers.

Whether the changes in the kidney in lead poisoning are due to changes in the blood vessels primarily or to a kidney change resulting in vessel changes and obstruction secondarily is still an open question with evidence on both sides. The blood vessels are affected, however, by the lead at some stage in the course of poisoning.

Neuromuscular system

(a) General

Lead affects both peripheral nerves and cells of the central nervous system. Changes in the nervous system are found in cord and in brain; there is degeneration of ganglion cells, interstitial neuroglia inflammation and peripheral neuritis. There is also irritation of the thoracic autonomic nervous system. The less advanced cases show the most marked changes in the peripheral nerves.

(b) Muscles

Lead has been found in the brain and in the muscles. In lead poisoning groups of muscles become paralyzed, gradually waste and show the reaction of degeneration. The muscles attacked are the muscles most used and either fatigue or previous muscular strain are factors. Goadby³ has found minute hæmorrhages in groups of muscles and minute blood extravasations in the nerves which supply the paralyzed muscles. Many observers state that the nerves of affected muscles show the lesions of interstitial neuritis with increase of the connective tissue framework and fibre degeneration.

(c) Eye

Loss of vision in lead poisoning may occur with no structural change in the fundus and is probably due to toxic conditions possibly associated with spasm of the blood vessels. Disturbance of sight even to amaurosis may be due to vasomotor influences on the blood vessels or to an action on certain brain cells. In some cases structural changes in the fundus can be demonstrated. Retinal hæmorrhages or acute neuro-retinitis has occurred in saturnine encephalopathy. When blindness follows headache and convulsions, the discs are swollen and hyperæmic, with obscured blood vessels, and retinal hæmorrhages. The hæmorrhage may never be entirely absorbed and the discs may atrophy.⁴

In other cases the changes in the eye seem to be those of subjects of kidney disease.

Brain symptoms may be due to arteritis. Arteriosclerosis and degeneration of the cerebral vessels with resultant restriction of the normal brain circulation would be a sufficient cause of encephalopathy. This condition could be caused by a direct action of lead or more indirectly by uræmia or anæmia.

1 L. Devoto, *Le alterazione dei vasi, dei reni e delle articolazioni nel saturnismo cronico*, 1911.

2 Rambousek, *Industrial Poisoning*, translated by Legge, 1913, p. 178.

3 Legge and Goadby, *Lead Poisoning and Lead Absorption*, 1912, pp. 81-109.

4 Oliver, *Lead Poisoning*, 1914, p. 144.

Mott¹ reported a case of chronic encephalitis with disseminated punctate hæmorrhages filling the peri-vascular spaces, resulting from both arterial and venous degeneration. There was considerable increase of neuroglia in both gray and white matter. No lead was found in the brain.

Minute hæmorrhages have been found in the cortex of the brain in poisoned cases and in experimental poisoning.

Goadby's² work in experimental poisoning shows the chief histological evidence to be capillary hæmorrhage and that minute hæmorrhages could frequently be traced before definite symptoms appeared. His work and Glibert's,³ he points out, support the theory that hæmorrhage and exudation are the earliest and initial change; the blood being the first thing affected by lead, the vessels being next to undergo degeneration.

¹ Mott, Archives of Neurology and Psychiatry, vol. 4, p. 117.

² Legge and Goadby, Lead Poisoning and Lead Absorption, 1912, pp. 81-109.

³ Glibert, La Saturnisme Expérimental: Extraits des Rapports Ann. de l'Insp. du Travail, 1906; Rambousek, p. 178.

CHAPTER III

SYMPTOMATOLOGY, SIGNS AND DIAGNOSIS

Lead poisoning may be either acute or chronic. Oliver is one of the very few to state exactly what he means by "acute" and his use of the term, namely, for cases of saturnine encephalopathy only, is by no means common. Unfortunately most of the authorities do not define their use of the word and, so far as can be judged from a study of the classifications under which they report their cases, there is in many cases some ambiguity in the writer's own mind and also, as a whole, great divergence of opinion between different writers as to the dividing line between the two classes.

The most that can be said from a study of the literature is that cases where marked symptoms, accompanied by disability, occur with rapid onslaught after brief exposure, are always classed as "acute," and that some writers use "acute" practically synonymously with "severe" without taking the period of exposure into account. Cases of encephalopathy and severe abdominal colic are seldom found under the heading chronic. Whatever may be the difficulty in deciding whether cases where there are severe symptoms manifested after long exposure should be classed as acute on account of their severity, or chronic on account of the long period of development, it is evident that such cases are readily detected and easily diagnosed as lead poisoning and that the chief problem lies in detection of chronic poisoning before the disease is fully developed. Such instances make up by far the greatest proportion of lead poisoning cases.

In chronic poisoning, continued absorption of lead affects the organs of the body gradually after long periods during which there are no *signal* manifestations of poisoning. Being primarily a disease of the blood vessels, liable to cause degeneration of the organs, especially heart, liver and kidneys, and atrophy of the digestive glands, it is obviously likely to produce symptoms common to many other organic diseases and, therefore, easily attributable to causes other than lead. Further, if, as is often the case, the nervous system is involved, a whole new range of symptoms may occur, and these again are common to many diseases other than lead poisoning.

Perhaps the two most characteristic features of lead poisoning are (a) the fact that lead can be stored up and retained in the body for years without signal symptoms appearing, and (b) the bearing of personal idiosyncrasy on both the kind and intensity of the symptoms produced. The first characteristic suggests the need of recognizing early indications or pre-symptoms, the second, the difficulty of establishing any universal criterion for diagnosis. It is impossible to point to any symptom which by its sole presence *proves* lead as its cause or by its absence denotes that the individual in question is not being affected by lead. Further, the part played by idiosyncrasy is so great that those who have the widest range of experience of cases of lead poisoning are the least able to agree as to what symptoms are the most commonly found. Thus some specialists make the presence of granular basophilia of a certain extent an infallible diagnostic standard, while others with equal experience deny that it is even notably characteristic of lead poisoning.

It is considerations such as the foregoing which are responsible for the axiom that wherever it is known that the patient has been exposed to lead,

trivial symptoms ordinarily negligible become significant, and warrant a tentative diagnosis of lead poisoning.

The most common symptoms and signs:

These, as judged by the collective witness of experts with long practical experience, are as follows:

Sallowness.

Anæmia.

Blue line on gums.

Colic.

Constipation.

"Wrist-drop" and paralysis of muscles.

Tremors of head, hands, neck, tongue, eyelids, etc.

Sweetish or metallic taste in mouth.

Loss of appetite, especially for breakfast.

Severe headache, especially in the frontal region.

Emaciation.

Diseased gums and teeth.

Nausea or vomiting.

Vertigo.

General lassitude.

Other symptoms and signs frequently noted:

Foul breath.

Arthralgia or so-called "rheumatism" or "lead gout."

Atrophy of optic nerve.

Increased blood pressure.

Granular basophilia.

Diarrhœa.

Lead in excretions.

Dyspepsia and general digestive disturbances.

Insomnia.

Fixed and drawn expression.

Less frequently noted symptoms and signs:

Increased tendon reflexes.

Marked increase in large mononuclear cells.

Duodenal ulcer.

Chronic appendicitis.

Mental symptoms:

Excitability.

Coma.

Loss of memory.

Hallucination.

Delirium.

Notes on some of the symptoms and signs of lead poisoning

(1) Colic

Attacks may be single, occasional or recurrent, and duration varies from a few hours to more or less continuous colic for a week or longer. Some patients have recurrent attacks fairly regularly at the same hour every day.

The pain may be extremely violent and in some cases increased, in others relieved, by pressure. It usually radiates from the navel but is sometimes in the ileo-cæcal region. The most characteristic feature of lead colic is that the abdomen is excessively hard and retracted. W. H. Rand¹ describes its typical appearance as "boat-shaped," and cites from Italian literature a case showing this peculiarity in a marked degree as follows: "In bed in the supine position, a line extending horizontally from the cartilage of the ribs to the pubes was 8 centimetres above the level of the navel. The spaces between the lower ribs were depressed, and there were three concavities on the abdomen, one in the central region about the navel and two smaller lateral ones just beyond the outer borders of the central abdominal muscles. Liquid poured over the ventral surface ran into these hollow spaces and remained there."

Other frequent accompaniments of pain are vomiting, constipation, slow, hard and feeble pulse, high blood pressure, scantiness of urine, absence of fever. Oliver² notes that sulphocyanide of potassium is usually absent from the saliva and Gilman Thompson³ refers to absence of perspiration and of leukocytosis and to the presence of strangury.

Distinguishing features of lead colic as contrasted with appendicitis and gall-stone colic

Gilman Thompson⁴ points out that the absence of fever and of leukocytosis and the central region of the pain differentiates lead colic from appendicitis. The latter point also differentiates it from gall-stone colic and in that disease bile is usually detectable in the urine and jaundice may be evident.

Local after effects

Oliver⁵ states that on subsidence of the acute pain, unilateral tenderness of the abdomen may remain for some days, associated with inequality of the pupils, inequality of the radial pulses and greater pain on one side of the neck than on the other on pressing upon the course of the vagal nerves. There may also be unilateral sweating of a portion of a limb.

(2) Wrist-drop and paralysis

Wrist-drop or paralysis of other muscles may be foreshadowed by gradual weakening or may occur without any premonitory symptoms and generally unpreceded by pain. The parts frequently affected are the extensors of the fingers, thumbs and wrists, but the muscles of the leg or feet are often attacked, sometimes the back, and in rare forms of poisoning the muscles of the eyes. Paralysis of the legs or feet is usually preceded by pain, numbness or tingling.

W. H. Rand⁶ points out that partial paralysis of the forearm can be most readily detected when the patient raises his hand and extends it horizontally with the fingers spread widely apart, as in this position the muscular tremor is much intensified.

Teleky, Edinger and Goadby hold that the paralysis usually attacks with greater severity those muscles which have been most in use. Dr. Alice Hamilton⁷ agrees with this view and cites in support, (a) experiments on frogs conducted by Mellon, of the University of Michigan, and (b) various instances in American literature, notably that of 55 cases of palsy in a lead smelter, of which the only

1 W. H. Rand, Occupational Lead Poisoning, U.S. Bur. of Lab. Stats., Monthly Lab. Rev., Feb., 1921, p. 138.

2 Oliver, Lead Poisoning, 1914, p. 138.

3 Gilman Thompson, The Occupational Diseases, 1914, p. 245.

4 Gilman Thompson, The Occupational Diseases, 1914, p. 270.

5 Oliver, Lead Poisoning, 1914, p. 138.

6 W. H. Rand, Occupational Lead Poisoning, U.S. Bur. of Lab. Stats., Monthly Labor Review, Feb., 1921, pp. 135-148.

7 Alice Hamilton, Lead Poisoning in American Industry, J.I.H., May, 1919, p. 20.

five examples of wrist-drop were in blast furnace tappers. She also notes that any injury or accident may determine the localization of the palsy.

(3) **Anæmia**

Anæmia is one of the commonest conditions noted in reports of chronic lead poisoning cases, but opinions differ as to whether it is the result of an active destruction of red blood corpuscles or of a lessened production. Oliver inclines to the view of deficient production as supported by the pale urine common in plumbism. Gilman Thompson¹ states that the red cells are not often found to fall below 4,000,000 and that the hæmoglobin usually falls to between 75 to 85%, sometimes to 50%.

Marvin Shie² doubts whether the characteristic pallor of lead poisoning is due to anæmia at all, and believes the latter is present less frequently than is commonly supposed. In most of his cases the red blood counts were but slightly below normal. He believes the pallor "to be due to a vasomotor constriction, a spasm of the peripheral arterioles, perhaps of a nature similar to the spasm of the intestines which so often occurs, and perhaps also similar to the muscular spasms which cause the painful muscular cramps, a rather common symptom. The hæmoglobin percentages vary considerably, but on the whole are not much lower than those found among any similar group of working people not affected with plumbism. None were found below 65%. The majority were between 80 and 100. This tends to bear out the hypothesis that the pallor is caused by constriction of the peripheral vessels rather than by secondary anæmia."

(4) **Marked increase of the large mononuclear cells**

Marvin Shie³ says that in his experience of chronic plumbism, increase in the large mononuclear cells ranging from 10% to 35% was "practically constant." The increase was frequently at the expense of the polymorphonuclear cells, sometimes at the expense of the lymphocytes. Hayhurst also states that many of the 100 painters he examined for lead poisoning showed a tendency to mononucleosis.

(5) **Increased blood pressure**

According to the experience of Legge and Goadby,⁴ the blood pressure of lead workers tends to be high; in an average of 100 cases, none showing signs of poisoning, the highest pressure was 178, the lowest 105, the mean 150. Collis⁵ found the average of 141 smelters to be 148.2 and of 38 white-lead workers, 156.5.

Oliver⁶ raises the question as to "whether high arterial tension is the consequence of lead *qua* lead upon the blood vessels or of the poisonous products formed in the body as the result of the action of lead upon such of the internal organs as the liver and kidneys." He refers to certain lead workers whose blood pressure alternately rose and fell during the first year's work, and comes to the following conclusion: "It seems to me that during the early years of employment in a lead factory, the work does not affect to any marked degree the blood pressure, but there is hardly any doubt that as time goes on and the function of the eliminating organs is interfered with, the blood pressure rises, also that structural changes are induced in the arteries, for only by this means can be explained the large number of deaths from cerebral hæmorrhage in persons who have worked in lead."

¹ Gilman Thompson, *The Occupational Diseases*, 1914, p. 247.

²⁻³ Marvin Shie, *Industrial Lead Poisoning*, Am. Med. Assoc. Jour., March 26th, 1921, p. 837.

⁴ Legge and Goadby, *Lead Poisoning and Lead Absorption*, 1912, pp. 115, 116.

⁵ Collis, E. L., *Special Report on Dangerous or Injurious Processes in the Smelting of Materials containing Lead*, 1910, p. 6.

⁶ Oliver, *Lead Poisoning*, 1914, p. 191.

In the experiments¹ carried out by Oliver and Professor Bolam in which they intravenously injected solutions of nitrate of lead into dogs, death resulted from a fall of blood pressure owing to the effect of lead upon the heart.

Oliver refers to a white lead factory where workers with arterial tension above 140 Hg. are rejected.

(6) Ulceration of the alimentary tract

Among the less frequent manifestations of chronic lead poisoning, European literature^{2,3} reports various instances of gastric and duodenal ulcer. The gastric ulcers are attributed to the intensive secretory irritation in the stomach caused by lead poisoning.

Harris⁴ found that some of the 400 painters he examined had symptoms suggestive of gastric ulcer or chronic appendiceal inflammation.

(7) The significance of lead in the urine

The presence of lead in the urine is no indication that the individual is lead-poisoned, but merely that he is evidently absorbing lead and might develop poisoning if at any time elimination were checked. Oliver looks upon such cases as "border line" cases. He says, "The presence of lead in the urine occupies the same relation to saturnism as Koch's bacillus does to tuberculosis, Eberth's bacillus to typhoid fever, and Klebs-Löffler's bacillus to diphtheria."⁵

Hayhurst⁶ similarly holds that detection of lead in the urine warrants a tentative diagnosis of lead poisoning. Harris⁷ also considers it a valuable diagnostic sign, having found it in most of his cases where other symptoms were present.

Rand⁸ points out that as elimination of lead by the kidneys is not constant but intermittent, a single negative urinary analysis is not proof that lead is not being absorbed, but a series of consecutive negative findings is required.

Legge and Goadby, Gilman Thompson, and according to the last, "many French and German writers," hold that lead is very infrequently found in the urine, especially in chronic cases of poisoning. Oliver, however, attaches more diagnostic value to the presence of lead in the urine than to the presence of basophilic degeneration in the blood.

Amount of lead in urine indicative of poisoning

Dr. Chapman, of Providence, contends that "from one-quarter to one-half a milligram (.00025 to .0005) of lead per liter of urine (estimated by standard methods), is sufficient to cause chronic plumbism."⁹

(8) Significance of lead in the faeces

Lead leaves the body in larger quantities by the faeces than by the urine. Oliver¹⁰ points out that if when lead reaches the stomach proteid food is being digested, only minute quantities of lead will be absorbed and the bulk of the poison will be thrown out in the faeces.

The finding of lead in the faeces does not of itself indicate lead poisoning, since elimination may be keeping up with absorption. Hayhurst¹¹ considers that it warrants a tentative diagnosis, but at the same time points out that it does not necessarily prove even lead absorption, since the lead may have been ingested in an insoluble and non-absorbable form.

¹ Oliver, Lead Poisoning, 1914, p. 186.

² Rinaldo Cassanello, Il Lavoro, 31. 10. 20, 11, No. 6, pp. 161-165. Abstracted in J.I.H., May, 1921, pp. 6, 7, supplement.

³ A. Schiff, Wien. Klin. Wchnschr., 10. 4. 19. 32, No. 15, 387. Abstracted in J.I.H., Jan., 1920, p. 144 of the supplement.

⁴ Harris, A Clinical Study of Lead, Turpentine and Benzine Poisoning in 400 Painters, 1918, p. 14.

⁵ Oliver, Lead Poisoning, 1914, p. 198.

⁶ Hayhurst, Industrial Health Hazards and Occupational Diseases in Ohio, 1915, p. 381.

⁷ Harris, A Clinical Study of the Frequency of Lead, Turpentine and Benzine Poisoning in 400 Painters, 1918, p. 3.

⁸ W. H. Rand, Occupational Lead Poisoning, U.S. Bur. of Lab. Stats., Monthly Lab. Rev., Feb., 1921, p. 140.

⁹ Quoted by McDonald & McCusker, Boston Med. and Surg. Jour., 4-11-20, p. 544.

¹⁰ Oliver, Lead Poisoning, 1914, p. 117.

¹¹ Hayhurst, Industrial Health Hazards and Occupational Diseases in Ohio, 1915, p. 381.

Legge and Goadby¹ state that the excretion of only about 2 milligrammes a day is not indicative of poisoning, and Goadby has at times found as much as from 8 to 10 milligrammes in the fæces of lead workers showing no signs or symptoms whatever of lead poisoning. They hold, however, that the presence of over 6 milligrammes a day "is definite evidence of an increased absorption of lead," and, in conjunction with clinical symptoms suggestive of lead poisoning, is highly significant.

Controversial points with regard to the value of certain symptoms for diagnostic standards

(1) Blue line on gums

There is what may be termed a "true" and a "false" blue line, the existence of the latter being facilitated by lack of personal cleanliness and, Oliver states, less frequent now than formerly. According to Oliver² "the true Burtonian or characteristically blue line of plumbism is not so readily removed, for it is due to a deposit of particles of lead sulphide inside the cells of the deeper layers of the gums."

Probably some degree of the divergence of opinion on the prevalence of the blue line as a symptom of lead poisoning is due to this ambiguity. Oliver considers that while even the true blue line is not in itself a proof of lead poisoning, it is an evidence of lead in the system and, together with other symptoms, is a valuable diagnostic sign.

Rambousek³ agrees substantially with this view but points out at the same time that mercury, iron and silver produce a very similar line and that workers in charcoal may also show a superficially similar phenomenon.

W. H. Rand⁴ considers the blue line "the most constant of the symptoms of plumbism," but neither inevitable in or peculiar to it, since in some cases it is lacking and a similar line arises from poisoning by the tetrachloride of gold or may be caused by the internal use of bismuth and copper salts.

Limenthal⁵ cites instances of undoubted lead poisoning where there was no sign of the blue line, and considers that the line is "extremely rare when the gums are in a healthy condition and when the teeth are cared for."

Harris⁶ found the lead line in less than 14% of the active cases among 400 painters and states that his own opinion, that the blue line is "infrequently encountered" in those whose teeth are kept clean, is shared by many of the New York plant physicians with experience of lead workers.

Hayhurst⁷ considers that the blue line is found in only about one-third of the cases and, while it is a sign of lead absorption and warrants a tentative diagnosis, it does not in itself prove poisoning.

Marvin Shie⁸ reports that 90% of all his patients had well-marked lead lines not invariably associated with bad gums and teeth. He considers all these to be potential cases of plumbism since the lead line proves absorption of lead.

(2) Granular basophilia or "stippling"

Granular basophilia is the name given to the condition when the red cells become filled with dark, fine granules. Some writers look upon basophilic granules as the result of degeneration, others as products of regeneration. Oliver says simply that their actual nature is not known. The relation between baso-

¹ Legge and Goadby, *Lead Poisoning and Lead Absorption*, 1912, p. 182.

² Oliver, *Lead Poisoning*, 1914, p. 133.

³ Rambousek, *Industrial Poisoning*, translated by Legge, 1913, p. 177.

⁴ W. H. Rand, *Occupational Lead Poisoning*, U.S. Bur. of Lab. Stats., *Monthly Lab. Rev.*, Feb., 1921, p. 138.

⁵ Limenthal, *Early Diagnosis of Lead Poisoning in Diseases of Occupation and Vocational Hygiene*, by Kober & Hanson, p. 97.

⁶ Harris, *A Clinical Study of the Frequency of Lead, Turpentine and Benzine Poisoning in 400 Painters*, 1918, p. 16.

⁷ Hayhurst, *Industrial Health Hazards and Occupational Diseases in Ohio*, 1915, p. 381.

⁸ Marvin Shie, *Industrial Lead Poisoning*, *Jour. Amer. Med. Assoc.*, March 26, 1921, p. 837.

philia and lead poisoning is the subject of much controversy, ranging for the most part around three points:

- (a) Whether granular basophilia is a characteristic of lead poisoning commonly found in most cases.
- (b) What is the diagnostic value of basophilia and what proportion of punctate cells to normal cells warrants a diagnosis of lead poisoning.
- (c) Whether it is more commonly found in chronic or acute cases.

(a) *Incidence of basophilia*

Not peculiar to lead poisoning.

That basophilia is not peculiar to lead poisoning is generally conceded, and it is reported as occurring in the following diseases: malaria, carcinoma, tuberculosis, dysentery, leukaemia, cachetic states, septic processes, secondary anaemia, and also in poisoning from phenylhydrazine, dinitrobenzene, aniline, and corrosive sublimate.

Basophilia in apparently healthy persons.

Basophilia is not in any case a disabling condition in itself, and it is sometimes, though rarely, found in healthy persons, as is testified by Oliver, Arthur Sellers¹, Teleky, and Otto Nageli,² the latter finding it in 21% of healthy persons examined, and noting that the number of basophile corpuscles increased after the eating of certain foods.

Reported cases of poisoning where basophilia was absent.

Limenthal³ reports that in nearly 50% of a large number of cases of lead poisoning in the out-patient department of the Massachusetts General Hospital, basophilic granules were absent.

Harris⁴ in a study of 103 active cases of poisoning noted absence of basophilia in 88%.

Dr. John Russell⁵ found that 27 out of 100 persons receiving compensation for lead poisoning in the Stoke-on-Trent area had no basophilia.

Lutoslawsky⁶ in 1902 found no basophilia in 17 out of 107 persons suffering from chronic plumbism.

P. Schmidt⁷ found no basophilia in 72.9% of 546 lead workers.

Teleky⁸ found no basophilia in 25 out of 79 patients showing blue line and cachexia and also complaining of illness.

Oliver⁹ reports absence of basophilia in at least 75% of his cases.

These findings are supported by expressions of opinion by Hayhurst, Rambousek, Rand, Biondi, Marvin Shie, Meyer and Speroni, all of whom state that basophilia is certainly not invariably present in lead poisoning.

Supporters of the view that basophilia is invariably present in lead poisoning.

Support of this view may be inferred from Schnitter¹⁰ who reports that *all* his cases of lead poisoning showed stippling and attributes the reputed absence in cases reported by others to the fact that fine stippling is obscured by the

¹ Sellers, *Blood Changes in Lead Workers*, J.I.H., Feb., 1921, p. 365.

² Nageli, *Blutkrankheiten und Blutdiagnostik*, Leipzig, Veit & Co., 1912, p. 155.

³ Limenthal, *Early Diagnosis of Lead Poisoning*, in *Diseases of Occupation and Vocational Hygiene*, by Kober & Hanson, 1918, p. 97.

⁴ Harris, *A Clinical Study of the Frequency of Lead, Turpentine and Benzine Poisoning in 400 Painters*, New York City Department of Health, 1918, p. 17.

⁵ Russell, *British Medical Journal*, Jan. 7, 1914, p. 143.

⁶ Lutoslawsky, quoted by Oliver, *Lead Poisoning*, 1914, p. 127.

⁷ Schmidt, quoted by Oliver, *Lead Poisoning*, 1914, p. 128.

⁸ Teleky, quoted by Oliver, *Lead Poisoning*, 1914, p. 128.

⁹ Oliver, *Lead Poisoning*, 1914, p. 126.

¹⁰ Schnitter, *Deutsch. med. Wchnsch.*, June 26, 1919, abstracted in J.I.H., Dec., 1919, p. 126 Sup.

counterstain used to show it up. He recommends staining with azure of Manson's methylene blue alone.

Variable nature of basophilia.

Meyer and Speroni¹ found basophilia present one day in lead-poisoned persons, absent another.

(b) *Basophilia and diagnosis*

The chief upholders of the diagnostic value of basophilia in itself are Grawitz, Hoffman of Leipsic, Schmidt of Leipsic, Behrend, Hamel, Moritz, Embden, Schnitter, P. Schmidt and Schönfeld.

The views of the last may be quoted as showing the extent of the claims made for basophilia as a criterion of poisoning. He assesses the relative dangers of different lead occupations by the incidence of basophilia among the workers and believes also that the presence of basophilia is the best guide there is for diagnosis. He attributes the decrease in lead poisoning since 1913 to early diagnosis being made from the results of blood examination.²

As opposed to this, Teleky and Rambousek, in common with the chief English and American authorities, insist that basophilia is only of supplementary value in conjunction with other signs and symptoms.

Certainly, if the evidence quoted in the preceding paragraphs is accepted, there is abundant proof that lead poisoning can exist without basophilia and basophilia without lead poisoning, and without even lead absorption.

Views on the degree of basophilia which is indicative of lead poisoning.

The most conservative view among those who stress the value of basophilia without other symptoms for diagnosis of lead poisoning is that the presence of 500 punctate cells per million warrants diagnosis. The most general names 300 as the basis and a few think 100 sufficient to indicate poisoning. The difference is, probably to some extent, incidental to different standards for differentiating between active and latent cases of poisoning.

Schnitter³ considers that workers with more than 100 stippled cells per million should not be allowed to work in lead and that those with more than 500 are definitely sick. Schönfeld⁴ considers that 100 warrants a positive diagnosis. He further expresses the opinion that 30 basophilia staining red cells per million are evidence of lead influence although no intoxication may have taken place. He believes polychromatophilia to be an even earlier sign.⁵

Hoffman and Schmidt,⁶ both of Leipsic, hold that the presence of 100 is suspicious and the presence of 300 warrants immediate suspension from lead work, and the State accepts this estimate as the basis upon which suspension of work should be enforced.

Another writer, P. Schmidt,⁷ thinks that a diagnosis of lead poisoning is warranted in cases showing 100 stippled cells.

Those who hold that basophilia, while of diagnostic value in conjunction with symptoms of poisoning, is not of itself conclusive, do not for the most part define so precisely what degrees are significant. Oliver⁸ says, "Personally, I could hardly recommend the suspension from work in a lead factory of any person whose erythrocytes showed basophile granules." Arthur Sellers,⁹ an

¹ Quoted by Oliver, *Lead Poisoning*, 1914, p. 129.

² J. Schönfeld, *Zentralbl. f. Gewerbehyg.*, Jan., 1921, 9, No. 1, pp. 3-7, abstracted J.I.H., Aug., 1921, p. 71, Sup.

³ Schnitter, *Deutsch. med. Wchnschr.*, June 26, 1919, abstracted in J.I.H., Dec., 1919, p. 126 Sup.

⁴ J. Schönfeld, *Zentralbl. f. Gewerbehyg.*, Jan., 1921, abstracted in J.I.H., Aug., 1921, p. 71, Sup.

⁵ J. Schönfeld, *Zentralbl. f. Gewerbehyg.*, Nov., 1921, 9, No. 11, pp. 256-264, abstracted in J. I. H., Jan., 1922, p. 27, Sup.

⁶ Hoffman and Schmidt, of Leipsic, quoted by Oliver, *Lead Poisoning*, 1914, p. 125.

⁷ P. Schmidt, quoted by Oliver, *Lead Poisoning*, 1914, p. 127.

⁸ Oliver, *Lead Poisoning*, 1914, p. 127.

⁹ Sellers, *Blood Changes in Lead Workers*, J.I.H., Feb., 1921, pp. 361-367.

English pathologist, made a special study in this relation of 22 lead workers, and his findings showed that the *proportion* of the punctate cells to the normal corpuscles bore no relation to the incidence of actual poisoning among the cases. None of those known to be poisoned showed more than 100 per million punctate cells, while 14 who showed more than 300 per million presented no symptoms of poisoning and appeared to be in good health. He sums up his results as follows: "It therefore seems clear that the examination of blood films as a routine measure for the control of lead workers, whether undertaken on an estimate of the proportion of red cells containing punctate granules or not, *would give results which would operate very unjustly both for the workman and the employer. It is probable that many incipient cases of lead poisoning would escape detection and it is certain that many men in good health would be excluded from their work.*"*

Gilman Thompson¹ states that basophilia in less proportion than 0.01% is of little diagnostic value, and Hayhurst thinks it insignificant unless present to the extent of 1 in every 100 red cells.²

(c) *Is basophilia most common in chronic or acute cases?*

This question has been little considered, and no consensus of opinion can be gathered from the scattered data bearing on the subject, since most writers omit to specify as to whether the basophilia they record occurred in chronic or acute cases. The references are collected here since it is felt that if any distinction could be established it would do much to explain the great divergence of experience by individual physicians of basophilia in their lead poisoning cases.

Hayhurst³ states that basophilia signifies acute intoxication of progressive character, and is uniformly absent in chronic cases of plumbism.

Marvin Shie⁴ agrees with this, but their experience appears somewhat different from that of other writers on the subject. Schönfield notes that the stippled cells tend to disappear when severe symptoms, such as nephritis or paralysis, occur, and Biondi failed to find it in his cases of severe lead intoxication. Also, Arthur Sellers found less basophilia in the three cases known to be suffering from lead poisoning than in the fourteen apparently unpoisoned.

Most of the European writers who value basophilia for diagnostic purposes use it for detection of lead poisoning in *early* stages. Oliver, on the other hand, records as his experience that it is more common in later stages. Much more data is required for even a tentative conclusion, and it would be valuable if those reporting basophilia would state whether they found it in acute or chronic cases.

(3) **Wassermann reaction in lead poisoning**

There is considerable obscurity around the question of the significance of the positive Wassermann reactions obtained from some lead patients.

Cyrus Field,⁵ of the Pathological Laboratory of Bellevue Hospital, obtained a positive reaction in 8 out of 12 cases examined, in at least 5 of which syphilis could be excluded. Gilman Thompson's⁶ experience has covered similar cases. Oettinger, Marie and Baron⁷ hold that a positive Wassermann reaction obtained in the course of saturnine intoxication does not allow us to conclude that it

* The italics are mine. R.M.H.

1 Gilman Thompson, *The Occupational Diseases*, 1914, p. 248.

2 Hayhurst, *Industrial Health Hazards and Occupational Diseases in Ohio*, 1915, p. 380.

3 Hayhurst, *Industrial Health Hazards and Occupational Diseases in Ohio*, 1915, p. 384.

4 Marvin Shie, *Industrial Lead Poisoning*, Jour. Amer. Med. Assoc., March 26th, 1921, p. 839.

5 Cyrus W. Field, Jour. Am. Med. Assoc., June, 1912. Quoted by Gilman Thompson, *The Occupational Diseases*, 1914, p. 251.

6 Gilman Thompson, *The Occupational Diseases*, 1914, p. 251.

7 Quoted by Oliver, *Lead Poisoning*, 1914, p. 159.

points to a syphilitic origin. They were, however, unable to obtain a positive reaction from guinea-pigs suffering from lead poisoning. The most positive view as to the non-syphilitic character of the Wassermann reaction in lead poisoning is taken by Schnitter,¹ who holds that it bears a relation to the number of basophile corpuscles present in the blood.

On the other side, Sicard and Bloch² got reactions only in cases where the syphilitic taint could not be ruled out, and this also was the experience of Harris.³

Oliver⁴ found positive reactions in cases where he considered that syphilis could be excluded. His view on the phenomenon is as follows: "The precise meaning of a positive Wassermann reaction in a large percentage of lead workers is not yet forthcoming. It must always be borne in mind that lead workers are, like other people, not free from syphilis, so that while in some instances a lead-poisoned person is also syphilitic, a circumstance to which the symptoms suggesting general paralysis may justly be attributed, there are others presenting similar symptoms who neither are nor have been the subjects of syphilis."

Standards for Diagnosis Suggested by the U.S.P.H.S.

The following sections dealing with classification of cases of lead poisoning and suggested standards for diagnosis have been abstracted or quoted in full from a recent publication of the U.S.P.H.S.⁵ The general adoption of these standards by industrial physicians and investigators would facilitate reliable comparisons of the incidence of lead poisoning in different trades and plants, a thing at present almost impossible owing to there being no uniform standards for diagnosis.

Classifications recommended

1. Positive.
 - (a) Acute.
 - (b) Chronic.
2. Presumptive.
3. Suggestive.
4. Negative for lead poisoning.

Connotation of the classifications

Positive.

Cases presenting symptoms and signs which are typical of lead poisoning and almost preclude doubt even without history of exposure.

Presumptive.

Cases with combination of symptoms and signs which could possibly be explained by some other condition, or "where some of the more prominent signs of lead poisoning were indefinite or not absolutely indicative of lead poisoning."

Suggestive.

Cases with "certain common symptoms which might indicate a degree of lead poisoning," but which are common symptoms of many complaints.

¹ Quoted by Oliver, *Lead Poisoning*, 1914, p. 159.

² Quoted by Oliver, *Lead Poisoning*, p. 159.

³ Harris, *A Clinical Study of the Frequency of Lead, Turpentine and Benzene Poisoning in 400 Painters*, N.Y. City Dep. of Health, 1918, p. 19.

⁴ Oliver, *Lead Poisoning*, in "Diseases of Occupation and Vocational Hygiene," by Kober & Hanson, 1918, p. 90.

⁵ B. J. Newman, W. J. McConnell, O. M. Spencer, F. M. Phillips, "Lead Poisoning in the Pottery Trades," U.S. P.H.S., May, 1921, pp. 84-88.

Tentative classification for an early diagnosis of lead poisoning

Line of demarcation between degrees of intoxication necessarily arbitrary.

"It is justifiable to recognize as suggestive of lead poisoning any group of symptoms of a similar nature in a number of workers exposed to the lead hazard, until the presence of such symptoms can be explained otherwise."

Diagnosis of chronic lead poisoning

"Where a fairly representative number of workers exposed to lead complain of similar symptoms, which did not exist before they took up their present employment, or which have become aggravated since, but which disappear with a change of work, the diagnosis of chronic lead poisoning is warranted, and a study of the conditions to determine or to disprove the presence of the lead hazard should be made."

Preliminaries to classifying cases under the suggested standard terms

Information should be secured on:

- (1) "History of known or suspected exposure to lead in any form.
- (2) The personal history and physical examination of the worker, with a view to eliminating conditions which would possibly simulate symptoms of lead poisoning."

Suggested standard terminology

"As an aid to a decision on the positiveness of lead poisoning it is recommended that a choice of any two or more symptoms, selecting one from each of the following groups, would, in conjunction with the numerous minor symptoms that are always present if these major symptoms are noted, be a reasonable basis for a diagnosis of positive lead poisoning. Should only one of these major symptoms appear, in combination with two or more symptoms of the presumptive group of the same general headings and also in conjunction with the minor symptoms that would be present, a diagnosis of chronic lead poisoning could also be made. Emphasis has been placed on the combination of the so-called major symptoms and the minor symptoms, because it is very unlikely that such major symptoms would ever be found alone in any case of lead poisoning. A combination of minor symptoms invariably accompanies more typical ones.

- A. General appearance.
Marked pallor and profound anæmia.
- B. Digestive system:
Colic.
Obstinate constipation.
- C. Muscular system:
Muscular incoordination.
- D. Nervous system:
Peripheral motor paralysis of certain extensor muscles (wrist and ankle drop) and atrophy of most used set of muscles.
- E. Vascular system:
Blood—basophilic degeneration with diminished hæmoglobin.
- F. Special organs and findings:
Gums—lead line.
Stools and urine—lead.
Miscarriage—repeated.
Liebermann's test—positive.

"In a like manner presumptive diagnosis would be suggested by the findings of any three or more symptoms selected singly from each of the following general headings. Here, also, a combination of minor symptoms assists a decision:

A. General appearance:

Pallor.
Anæmia.
Emaciation.
Drawn expression.

B. Digestive system:

Loss of appetite or repugnance to food.
Breakfast anorexia.
Vomiting on eating solid food.
Sweetish or metallic taste.
Gastric disturbances.
Constipation.
Pain in abdomen.
Parotitis.

C. Muscular system:

Loss of strength.
Malaise and tiring easily.

D. Nervous system:

Headache.
Insomnia.
Mental lethargy.
Tremor.
Dizziness.
Convulsions.
Mental affections.
Encephalopathic conditions.
Arteritis.

E. Vascular system:

Arteriosclerosis.
Hypertension.

F. Special organs and findings:

1. Eyes;

Impairment of vision, including muscular incoordination.

2. Joints;

Various pains.

3. Blood—basophilic degeneration with diminished hæmoglobin.

"While it is true that in other industries as well as in potteries, workers show on numerous occasions and under varying conditions symptoms which, when taken in conjunction with other symptoms, may be characteristic evidence of some degree of lead poisoning, yet such symptoms would be only suggestive of this particular poisoning. However, if his occupation exposes the worker to a lead hazard, and if any combination of the following symptoms appears among a number of workers so exposed, the association between such symptoms and such exposure would justify the industrial physician in suspecting lead

as the causative agent in inducing these symptoms and would justify him in making a diagnosis of suggestive lead poisoning:

Constipation.
Loss of weight.
Loss of strength.
Drowsiness.
Pain in lumbar region.
Pain in joints.
Headache.
Insomnia.
Confusion.
Loss of morning appetite.
Metallic or sweetish taste."

Qualifications and precautions.

(1) Elimination of confusing conditions (i.e., causes other than lead.)

(2) Realization that lead workers are, as others, subject to disease and intoxications arising from causes other than work and producing the same symptoms as those of lead poisoning. Distinction must be kept between "caused by the occupation" and "concomitant with."

Tentative diagnosis.

Warranted where there are "suggestive" or "presumptive" symptoms.

CHAPTER IV

LABORATORY AND CLINICAL TESTS FOR LEAD

I. The determination of lead in the air of workrooms

Any method for determining the quantity of lead in the air of workrooms requires a known quantity of air to be drawn through a filter or collecting chamber capable of arresting the lead, which can then be estimated gravimetrically or colorimetrically. The necessary apparatus consists of a calibrated aspirator and a collecting tube or filter.

The aspirator

Any pump or suction apparatus may be used as an aspirator provided it can be calibrated to measure the quantity of air passing through. Large suction bottles filled with water, single action pumps with the valves working in oil and a layer of oil over the piston to prevent air leakage, artificial respiration pumps such as are used in experimental physiology, and the Palmer water-spray dust-collecting apparatus have been used. The pumps, if not already calibrated to show the air per stroke, may be calibrated by connecting to a meter and by ensuring that the stroke shall always be taken in the same way. The Palmer apparatus may vary in rate, and large quantities of air should be used to decrease the error. For other aspirators, 100 to 300 litres of air are usually sufficient for one determination.

The collecting tube or filter

The air is filtered through cotton wool, water, or acid solutions. The water and acid collecting fluids have not been found as effective as cotton wool. They should be used in long containers and the air should be broken up by passing through a bulb with fine perforations; the rate of flow must be slow.

The best filter is the one used by Duckering¹, which consists of a small weighing or suction bottle containing a collecting tube packed with cotton wool, through which the air must pass. The weighing bottle has an outlet tube for connection to the aspirator. The inlet tube leading to the cotton wool is placed at the point at which it is desired to ascertain the quantity of lead in the air. This inlet tube should on entering the suction bottle expand to decrease the velocity of the air current; it may be well to have a right angle in its course just before entering the bottle. This inlet tube further expands sharply into the collecting chamber packed with cotton wool held in place by silk tied over the open mouth.

Estimation of lead from the collecting tube or filter

This is best done by Duckering's modification of Harcourt's colorimetric method.² The bulk of the deposit on the cotton wool is tapped gently into a beaker, and the upper third of the cotton wool, containing the remainder of the lead, is added to the same beaker. Two and a half c.c. of diluted nitric acid (one part of concentrated acid to three of water), and a little water are added and after heating the solution is filtered into a 50 c.c. Nessler tube. The remainder of the cotton wool is treated with 2 c.c. of the nitric acid and the solution added to the first beaker. After heating, this is filtered; the wool is washed several times with hot water and the filtrate in each case is added to the Nessler tube. To this

¹ Duckering, Ann. Rep. of the Chief Inspector of Factories, 1910, p. 201.

² Duckering, App. XLIX of the Report of the Committee on the Dangers of the Use of Lead in the Manufacture of Earthenware.

is added 5 c.c. of caustic soda solution (100 grams in 250 c.c. water) and 4 c.c. of a saturated solution of sugar in water. Standards are prepared in Nessler tubes containing 0.5 to 1.5 c.c. of lead solution (a solution of lead acetate or lead nitrate made up to contain 0.0001 gram of lead per c.c. of solution) or higher if necessary, varying with the quantity of air aspirated for the sample. To these standards are added $4\frac{1}{2}$ c.c. of the nitric acid, 5 c.c. of caustic soda solution, and 4 c.c. of the sugar solution. As the air sample is usually coloured slightly yellow (owing to certain substances in the workroom air, and to the cotton wool used), it is usually necessary to add to the standards a coloured solution until it matches the air sample tube. This coloured solution is prepared by dissolving cotton wool in concentrated nitric acid, evaporating to dryness and redissolving the residue in a little water, then filtering. To the contents of the Nessler tubes is added 4 c.c. of freshly prepared hydrogen sulphide water and the sample tube is matched with the standards. The quantity of lead in air is usually stated in milligrams per 10 cubic meters of air.

II. Technique for diagnostic tests

1. Determination of lead in urine, faeces, post-mortem specimens and other organic substances

A.—Separation of lead from its organic associations

The analyst cannot rely upon direct tests for poisonous metals, if animal and vegetable matter is present. Consequently complete destruction of interfering organic substances is absolutely essential. Two methods are applicable for this purpose: the "wet" and the "dry" methods, so termed from the original treatment of the substance. In the dry method, the substance is incinerated with or without the addition of sulphuric or nitric acids. In the wet, the material is treated with hydrochloric acid and potassium chlorate. Subsequent treatment in both cases is similar. The wet method is especially suitable where the quantity of organic matter present is large, as in faeces.

(1) *Moist method—method of Fresenius and Von Babo.*¹

The substance to be tested, if solid, is finely chopped and mixed in a large evaporating dish (15 cm.) with distilled water sufficient to produce a fluid mass. Urine should be evaporated to a consistency of gruel. Crystals of potassium chlorate are added, each 100 gm. of substance requiring 3-4 gm. of chlorate. Concentrated hydrochloric acid is added so as to make the mixture have an acid concentration of 12-14%. The evaporating dish is covered with an inverted funnel, placed on a water bath and gently heated. If necessary, additional crystals of potassium chlorate are added from time to time until most of the organic matter is dissolved. Fat especially resists the action of chlorine and requires continued treatment. When the liquid has become clear and is of a light yellow colour, the funnel is removed and the dish allowed to remain on the water bath until the smell of chlorine has disappeared. It is then filtered *hot* and the lead determined either gravimetrically or colorimetrically as later described.

H. Thoms' Modification²

Thoms destroys the organic matter in an ordinary distillation flask with the side arm bent upwards. A separatory funnel fits by means of a stopper into the neck of the flask. The minced organic matter is thinned in the flask

¹ Fresenius and Von Babo, *Annalen der Chemie und Pharmacie*, 1844, vol. 49, pp. 287-315.

² H. Thoms, *Einführung in die praktische Nahrungsmittel Chemie*, Leipzig, 1899. Published by S. Hirzel, *Abbildung 64*, p. 153.

with 12.5% hydrochloric acid. The separatory funnel contains an aqueous solution of potassium chlorate (1:20) saturated at room temperature. Add about a gram of solid potassium chlorate and warm the flask on a boiling water bath. When the mass is warm, run in the chlorate solution, drop by drop, and shake constantly. Care must be taken not to add the solution too rapidly; otherwise the procedure is identical with the Fresenius-Von Babo method.

(2) *Dry method.*¹

This is effected by incinerating the finely divided substance at a very low red heat in a muffle. When cold the residue is treated with nitric acid and sufficient heat applied to drive off the free acid. The nitrate of the metal is then dissolved in water and dealt with according to the method used for the estimation of the lead.

Variations of dry method described by different authors

(a) *Method quoted by Oliver.*²

"In testing for lead in urine, Professor Bedson, Armstrong College, Newcastle-upon-Tyne, makes use of the following method: 50 c.c. of urine are placed in a shallow porcelain basin and evaporated practically to dryness on a water bath; it is carbonized in a muffle furnace; the residue is moistened with strong nitric acid, and ignited gently. The residue is perfectly white. This is moistened with strong hydrochloric acid and evaporated to dryness. It is ignited gently on a muffle and cooled; a few drops of hydrochloric acid are added, and then water; it is allowed to stand for a few minutes, after which it is poured into a Nessler glass. The solution is made just alkaline with a few drops of ammonia, then slightly acid with a few drops of hydrochloric acid. If necessary it is filtered, and the amount made up to 50 c.c. To this are added 2 c.c. of freshly prepared sulphuretted hydrogen. A dark coloration indicates lead (all other metals being known to be absent). The estimation of the amount of lead is effected by a comparison of the coloration produced under like conditions with a standard lead solution."

(b) *Method used by Graham, Rogers and Vogt.*³

"A litre of urine was evaporated to dryness on a water bath, the residue moistened with nitric acid, and when effervescence had ceased, the bright-coloured residue was transferred to a platinum crucible, heated and carefully ignited. The crucible and contents together with distilled water were placed in a beaker, hydrochloric acid added, filtered hot and washed with hot water. To the filtrate was added ammonium hydrate and ammonium sulphide for the purpose of precipitating the lead with phosphates and iron. The filtrate was washed by decantation, an excess of hydrochloric acid added to dissolve the sulphide of iron and the phosphates. After standing some hours, the mass was filtered, washed with boiling water, and to the residue of the filter nitric acid added; after washing into a beaker, the material was evaporated to dryness, dissolved in a very little acetic acid and a very small quantity of sulphuric acid added, sufficient, however, to cause complete precipitation. A cloudy precipitate indicated lead, which was placed in small cylinders about six inches long, which was compared with a similar cylinder containing an equal amount of a trial sample of sulphate of lead. By comparison of the colours it was easy to calculate the amount of lead present. Where the colour did not compare, new trial samples were made until the colours matched."

1 A. W. Blyth, *Poisons: Their Effect and Detection*, p. 635.

2 Oliver, *Lead Poisoning*, 1914, p. 192.

3 N.Y. State Factory Investigating Commission, 1913, vol. II, p. 1089.

(c) Method of Shufflebotham and Mellor.¹

Shufflebotham and Mellor describe the following method as one by which lead may be detected in organic tissue, and in each case this necessitated a large amount of evaporation.

"On the Detection of Lead in Urine and Post-Mortem Specimens: A piece of kidney of 20 c.c. capacity was cut up into about a dozen pieces. These were placed in an evaporating basin, and about 50 c.c. of fuming nitric acid were poured into the dish. Dense brown fumes of nitrogen oxides were evolved. When the action had subsided (in from two to three minutes), the dish was placed upon a sheet of asbestos, and allowed to simmer over the bunsen flame for about an hour. If the frothing appears in danger of running over the sides of the dish, stirring with a glass rod or removal of the flame for a short time may be necessary. Twenty-five c.c. of the fuming acid were added at intervals of a quarter of an hour, and this process was repeated three times. The destruction of the organic matter was so complete that the whole of the piece of kidney passed into complete solution. The solution was then evaporated down to a few c.c., neutralized with caustic soda, filtered, and treated with hydrogen sulphide. A dark-brown precipitate of lead sulphide was obtained. With potassium chromate a yellow precipitate of lead chromate was obtained with the same specimen of kidney which gave a negative result with the $\text{KClO}_3\text{-HCl}$ method of destroying the organic matter. Our reagents, dishes, etc., were then examined with a blank test, but we found no lead.

"Urine: We then sought the presence of lead in the urine of Cases 2, 3 and 4. Half a gallon of urine was evaporated down to dryness in each of two basins. In one basin the residue was heated until it was charred. Both residues were then treated separately with fuming nitric acid, as just described. The uncharred residue passed into solution, and on cooling deposited a white sediment. The mother-liquor was neutralized and tested in the usual way. A brown precipitate of lead sulphide was obtained in Case 2, while in Case 3 a well-marked black precipitate was obtained. The urine of Case 4 gave a negative result. The charred residue did not pass completely into solution, and the tests for lead were not so well defined as when the residue was uncharred. This shows that care must be taken to prevent charring of the residue during evaporation."

(d) Denis and Minot method for detection of lead.²

i. In urine.

Evaporate 2000 c.c. to dryness and allow to char slightly, cool and mix residue in a crucible with 8 gm. of powdered sodium nitrate. Incinerate in a muffle furnace. Cool, transfer to 300 c.c. beaker, and add 10% HCl until (faintly) acid. Heat to boiling and filter hot and wash with boiling water. Make faintly alkaline with NH_4OH . Add 2-3 drops of 1% CuSO_4 solution and precipitate the Pb and Cu with H_2S . Separate the precipitate by centrifuging and wash it once with water, 5 times with N/10 HCl and then again with water. Transfer residue of PbS and CuS to a 25 c.c. platinum crucible by means of 3 c.c. of dilute HNO_3 (1:4) and wash tube with 3 c.c. of water. Using the crucible as the anode and a platinum spiral as a cathode, pass through a current of 3-3.5 amp. and 5-6 volts for 15 minutes. Draw off the acid solution, disconnect the circuit, and wash the crucible and spiral with water. Add 5 c.c. of 5% KI solution (free from iodate) and 1 c.c. of 25% acetic acid. Allow to

¹ Shufflebotham and Mellor, *The Lancet*, 1903, II, p. 746.

² *J. Biol. Chem.*, 1919, 38, pp. 449-52.

stand for 5 minutes to ensure complete decomposition of the PbO_2 into PbI and the liberation of free I . Transfer to a small beaker and titrate the liberated iodine with .005N $\text{Na}_2\text{S}_2\text{O}_3$ solution, using starch as indicator. One c.c. of .005N $\text{Na}_2\text{S}_2\text{O}_3$ is equivalent to .517 mg. of Pb . .005N $\text{Na}_2\text{S}_2\text{O}_3$ solution will not keep well and must be made up every 10 days.

ii. In fæces or tissues.

Spread on an ordinary china plate 500 gm. of soft fæces or 100 gm. of muscle, liver or other tissue. Place the plate on an electric hot plate and dry the substance. Grind the material to a coarse powder in a porcelain mortar and mix with half its weight of NaNO_3 and transfer to a crucible. Ignite slowly at first with a Bunsen flame and later in a muffle furnace. Then proceed as described above in the case of urine.

(e) *Method recommended by Harris.*¹

"After trying the Blyth and several other methods for the determination of lead in the urine, Mr. Durand* finally devised a method which gave accurate and fairly delicate results, and yet did away with the boiling over of the tarry mass of urine usually formed in the test, and so made unnecessary that constant watching without which most tests were spoiled. His method is the following: 200 to 300 c.c. of urine are treated with 5 c.c. of bromine in a porcelain casserole, and evaporated on a hot plate to about 50 c.c. It is then transferred to a platinum dish and evaporated nearly to dryness; 10 c.c. of concentrated nitric acid is then added and the evaporation continued to dryness, the residue again moistened with nitric acid and evaporated to dryness. The residue is then ignited to a low red heat to burn off carbonaceous matter. It is cooled, taken up with 4 to 5 c.c. water and 2 to 3 gm. ammonium carbonate, evaporated to dryness, and the flame played on the dish until the ammonia is driven off. It is then taken up with 15 to 20 c.c. of 10 per cent. acetic acid and boiled and filtered hot into a small test tube. It is then cooled and 1 to 2 drops of colourless ammonium sulphide and a drop of 25 per cent. hydrochloric acid added, and compared with standard samples prepared by adding known amounts of a solution of lead acetate containing 1 gm. of lead per 1,000 c.c. Even less than 0.025 mg. gave a distinct reaction."

B.—Electrolytic method of collecting lead from solution for estimation

Electrolysis may be used to separate lead from the solution into which it has been brought by the moist or dry method.

Variations of the electrolytic method described by different authors

(a) *The electrolytic test described by Hayhurst.*²

"Materials and apparatus (lead-free): (1) beaker of 200 c.c. capacity, (2) evaporating dish of 1 litre capacity, (3) conc. HNO_3 c.p., (4) conc. HCl c.p., (5) NaOH sticks, (6) Swedish filter paper, 3 and 6 inches in diameter, (7) cover-glass, or glass funnel, to be inverted over beaker. Also two 5-inch lengths of medium sized platinum wire for electrodes. Platinum truncated cones are better. Also 3 ordinary dry-cells connected in series, with several feet of ordinary insulated bell-wire, brass wire-connectors, a miniature rheostat, a small combined voltmeter and ampere-meter (the watch-shape type costing about \$2.00 is satisfactory), and 1 or 2 single-blade switches to facilitate control of current.

¹ Harris, Clinical Study of the Frequency of Lead, Turpentine and Benzine Poisoning in 400 Painters, N.Y. City Dep. of Health, 1918, p. 17.

* Chemist in the New York Department of Health.

² Hayhurst, Industrial Health Hazards and Occupational Diseases in Ohio, 1915, pp. 387, 388.

Generate H_2S gas by placing lumps of FeS in a bottle having a glass delivery tube drawn out to a point, adding half-strength HCl whenever gas is wanted. All the work should be done inside of a laboratory hood, to get rid of odours, acid fumes, etc. The whole apparatus can be set up on one small iron standard, with a few rings and clamps. The platinum electrodes are coiled up in the form of spirals, and each connected to a respective wire from the batteries. The electrodes are let down inside of the beaker, so as to be near the bottom, and not closer than half an inch from each other. Lead in the solution will deposit on the negative pole as PbO_2 . To determine the electrode or pole, place a weak solution of NaCl in the beaker containing a drop or two of phenolphthalein indicator; pink colour appears at the negative pole when the current is turned on.

Procedure: A 24-hour specimen of urine is evaporated down until all is contained in the evaporating dish. Then add carefully 30 c.c. of pure nitric acid, bring to a boil, evaporate down to a total of 60 c.c. This changes all lead present into the nitrate, which is in solution, and the carbon from the organic compounds appear as black flakes. Filter to remove carbon. The filtrate, together with the washings to 90 c.c. are now placed in the beaker fitted with the electrodes and covered to prevent foreign matter accidentally dropping in. The electrodes should have been previously boiled in a mixture of HNO_3 and HCl to brighten them, then washed in distilled water. The current is thrown on, and adjusted by means of the rheostat, so that about 2 volts is read on the voltmeter temporarily attached at the electrodes. This shows the actual delivery current, as there is considerable resistance in the wires at the low voltage used. The amperage will be found to read about 4, but is of variable quantity. The current is continued through the solution for 8 to 10 hours. It is best to immerse the beaker in a water bath, kept at about 30° to 40° C. by means of an electric lamp, as the current action is better."

(b) *Electrolytic method of Dixon Mann.*¹

Legge and Goadby² consider the electrolytic method best for the detection of minute quantities of lead, as in the urine, fæces or vomited matter.

After destruction of the organic matter by the wet method of Fresenius and Von Babo, the filtrate is cooled and placed in the inner cell of a two-celled arrangement, the bottom of which is formed of vegetable parchment. The outer cell contains distilled water acidulated with H_2SO_4 to the same level as the liquid in the inner cell. A piece of platinum foil enclosing a surface of about 50 sq. cm., constituting the cathode, is submerged in the inner cell and a similar piece for the anode is immersed in the outer cell. The pieces of foil are so placed as to be opposite each other, separated by the parchment diaphragm. When the circuit is now closed, any lead in the filtrate will be deposited on the platinum foil in the inner cell. After passing a current having a voltage of from 3-4 volts for six to eight hours, the cathode is removed and washed and dried. The metallic lead is dissolved from it with dilute nitric acid aided by heat. The free acid is driven off and the solution decomposed with dilute H_2SO_4 and an equal volume of alcohol to expedite precipitation. It is then allowed to stand for 24 hours, the precipitate of lead sulphate washed by decantation with 12% alcohol until free of acid, filtered, ignited and weighed.

(c) *Method of J. Hill Abram and Prosper Marsden.*³

"A strip of pure magnesium is placed in the fluid to be examined. Ammonium oxalate in the proportion of about 1 gram to 150 c.c. is added. If lead

¹ Dixon Mann, *Forensic Medicine and Toxicology*, p. 496.

² Legge and Goadby, *Lead Poisoning and Lead Absorption*, 1912, p. 174.

³ John Hill Abram, *Three Cases of Lead Poisoning with a Note on a Simple Method for the Detection of Lead in Organic Fluids*, *Lancet*, 1897, 16, 1, pp. 164-165.

is present, it is deposited on the magnesium. A deposit is seen within half an hour, but we have usually left it 24 hours. The slip is then washed with distilled water and dried. Confirmatory tests: (1) Warm the slip with a crystal of iodine (yellow iodide proves lead, cadmium may be ignored); (2) dissolve deposit in HNO_3 and apply usual tests. The magnesium can be used again after careful washing with acid and distilled water. The surface of the magnesium, when used, must be bright and free from oxide. The delicacy of the method has been tested with aqueous solutions containing known quantities of lead, also with normal urine to which known quantities of lead have been added. In all cases a control experiment was performed to insure the freedom of the materials from lead. Lead has been detected when present in the proportion of 1 part to 50,000, whether in simple aqueous solution or in urine."

C.—Method of detecting and estimating lead

(1) Qualitative tests

Qualitative tests are of little value until the substance to be tested is freed of all its organic associations. The presence of other metals frequently interferes with the reactions. The group reagent for lead is hydrogen sulphide in acid and alkaline solution. By this reagent lead is precipitated as a black precipitate. Sulphuric acid and soluble sulphates give a white precipitate. Potassium chromate gives a yellow precipitate of lead chromate insoluble in acetic acid. Potassium iodide gives a yellow precipitate of lead iodide soluble in warm acetic acid but crystallizing from it on cooling.

Methods (a) and (b) are especially used for detecting minute amounts of lead qualitatively.

(a) An excellent method of identification of a lead salt is to form the sulphate and then convert it into the acetate. This is done by boiling the sulphate with ammonium carbonate (which changes it to the carbonate), and now by treatment with acetic acid the acetate is obtained. If lead is present in a minute amount concentrate the solution in a watch glass. Evaporate a drop to dryness on a microscope slide and if a fine crystalline substance possessing a sweet taste and blackening when exposed to hydrogen sulphide is obtained, the substance must be lead acetate.

(b) A somewhat similar method of identification may be employed in the formation of the potassium copper lead nitrate as follows: Incinerate material and form the nitrate by addition of nitric acid. Evaporate to dryness, add a few drops of acetic acid and transfer a drop to a microscope slide. To the drop on the slide add a drop of dilute copper acetate and 2 or 3 drops potassium nitrate. Stir drops together and allow to stand. If lead is present violet black cubes of potassium copper lead nitrate appear. This reaction is said to be sensitive to .0003 gm. of lead.

(c) A method for the detection of lead in urine has been recommended of suspending a small bag of calcium sulphide in the sample to be examined. It is supposed that should the calcium sulphide in the bag show blackening, it would be due to lead. This according to Sir Kenneth Goadby is very doubtful.¹

(d) A further confirmatory test may be used by inoculation of the urine to be examined with *bacillus coli communis* (a small quantity of faeces will answer this purpose). The bacteria in its growth uses up the organic constituents and liberates hydrogen sulphide. The urine is then filtered, the residue dissolved in dilute nitric acid and tested for lead by the usual tests. Goadby² obtained satisfactory results by this method.

¹⁻² Legge and Goadby, *Lead Poisoning and Lead Absorption*, 1912, p. 168.

(2) Quantitative estimation of lead

The methods most frequently employed for estimation of small amounts of lead quantitatively are:

- (a) The colorimetric sulphide method.
- (b) The gravimetric or volumetric sulphate, molybdate and chromate methods.
- (c) The electrolytic method in which lead is estimated as lead oxide.

(a) Colorimetric.

This method of estimating lead was first proposed by Pelouze in 1842. He converted the lead into the sulphide and compared the intensity of the coloration with standard lead sulphide solutions. The best procedure after the lead is obtained in solution is to remove any interfering substances, such as iron. This is done by converting the iron present into the ferrous state by means of sodium thiosulphate. The ferrous iron is then changed by the addition of ammonia and potassium cyanide into a complex cyanide compound, which no longer interferes by giving a coloration with alkaline sulphide. This method avoids the actual separation of the iron and has some advantages. A soluble sulphide—sodium or ammonium sulphide—is now added and the intensity of colour produced compared in Nessler tubes with standard lead solutions.

In order to prevent the interference of other substances in estimating lead in this way, various means have been employed in effecting a degree of purification. The addition of sugar or glycerine to the solution gives greater uniformity of tint and slightly decreases the opacity of the solution.

Method recommended by the Division of Occupational Diseases, Ohio State Board of Health.¹

With a view to standardizing a convenient method for determining lead in the urine, an investigation was made into the four methods in most general use, namely:

- i. "Electrolytic precipitation of lead as lead peroxide; confirming it by dissolving in aqua regia and subsequently testing with hydrogen sulphide.
- ii. Use of organic test reagents (tetramethyldiamino-diphenylmethane) which produces a blue colour with lead peroxide.
- iii. The use of potassium dichromate to precipitate the lead in the form of yellow lead chromate.
- iv. Precipitation of lead with hydrogen sulphide or some soluble sulphide."

Precipitation of lead as the sulphide the best method.

It was decided that iv above was the best method. The electrolytic test requires very exact conditions and considerable experience and is not as delicate as the sulphide test. This latter was further investigated to determine its delicacy and to establish certain details of procedure.

Delicacy of the test—

It was estimated that for "a casual observer" the delicacy of the test is 1 to 1,000,000.

Procedure to be followed—

(1) Evaporate at least 1,000 c.c. of the suspected urine down to about 20 c.c.

(2) Destroy the organic matter with nitric acid by the following method: "Evaporate the sample to a volume of about 20 c.c. Add 20 c.c. of strong

¹ Chas. Parkinson, The Standardization of a Method for the Detection of Lead in Urine, 1914.

nitric acid (sp. gr. 1.42). Evaporate to 10 c.c., keeping the material washed down from the sides of the dish. Flakes of carbon will form and tend to persist if this is not observed. Add 20 c.c. of water. If the solution is water-clear the destruction of organic matter may be regarded as complete. If the flakes of carbon are present, or if the solution is a yellow colour, transfer it to a small evaporating dish and evaporate until the residue begins to char or spatter. Mix in 5 gms. of sodium carbonate and heat until the ash is pure white. All organic matter is thus destroyed."

(3) "After the organic matter has been destroyed, make the solution alkaline to litmus by adding ammonium hydroxide. If any iron is present it will appear as a brown flocculent precipitate. If copper is present the solution will assume a bluish hue. If iron is present acidify the solution with HCl. If copper is present add KCN to the alkaline solution till the blue colour disappears. (Great care must be taken not to add potassium cyanide to a solution which reacts acid to litmus paper, because of the generation of dangerous hydrocyanic acid fumes.) If iron and copper are both present, add 0.5 gm. tartaric acid, make alkaline and add KCN till the blue colour disappears. (The tartaric acid should be examined for lead.) If the test for lead is to be made in *acid solution*, add 5 c.c. of a saturated solution of H_2S in water, or allow the gas to bubble through the solution. If the test is to be made in *alkaline solution*, instead of H_2S in water, a solution of a soluble sulphide, preferably sodium sulphide, Na_2S , may be used; this does away with having to generate H_2S gas. (Ammonium sulphide is not as desirable because of its strong yellow colour.) The darkening produced is practically proportional to the quantity of lead present. In some cases where a very small amount of lead is present a brownish colour is produced. In order to confirm this as being due to lead the following further test may be employed: Boil out all excess of hydrogen sulphide, add hydrogen peroxide, full strength U.S.P., and let stand. If the dark colour disappears, due to the oxidation of lead sulphide to lead sulphate (which remains soluble in the quantities found here), it signifies that the darkening was due to lead in the form of sulphide. The action of hydrogen peroxide on other black sulphides, as the sulphide of copper, mercury, bismuth, nickel, cobalt and iron, was investigated and in no case is a similar reaction observed. Mercuric sulphide is unattacked, copper, nickel, cobalt and iron give coloured solutions. Bismuth yields a white precipitate, due to the formation of basic salts."

"The time required for the detection of lead by this method will not exceed $3\frac{1}{2}$ to 4 hours, including the time for evaporating the urine, which may be left to an assistant. The actual chemical tests require less than one-half hour. It does not require the undivided attention of the operator and several tests can be run at the same time.

"Apparatus necessary:

1 evaporating dish, 1,000 c.c. capacity.

1 evaporating dish, 50-75 c.c. capacity. (Dishes glazed with a lead glaze should not be used. Royal Bohemia ware is recommended).

2-4 Nessler tubes or test-tubes of uniform size and colour.

1 Erlenmeyer flask.

A white background to compare colours over.

Ring-stand, rings, Bunsen burner, etc. Keep clean so as not to drop iron rust into solutions.

"Reagents necessary:

(a) To destroy organic matter:

Nitric acid (sp. gr. 1.42).

(b) To remove iron or copper occurring as impurities:

Ammonium hydroxide (weak).

Litmus paper.

Potassium cyanide.

Tartaric acid.

(c) Test solutions:

Hydrogen sulphide or sodium sulphide solution 10% (filter if necessary).

Hydrogen peroxide, U.S.P.

"The impurity apt to be introduced through the reagents which has to be considered here is *iron* in the potassium chlorate. A blank test for *lead* should be run on all reagents, especially the potassium chlorate and for the control of all operations. This can be done very conveniently by running a sample of lead-free water along with the sample of suspected urine, adding the same reagents and performing the same manipulations. This solution is also very useful as a blank for comparison."

(b) *Gravimetric.*

The *sulphate method* is used to advantage in cases where the lead is present to the extent of 10 milligrams. Since the lead content of urine is much lower than this in practically all cases, this method is never used in urine analyses and only occasionally in cases of faeces and tissues. After incinerating the organic material and obtaining the lead in solution, the solution is decomposed by addition of dilute sulphuric acid and an equal volume of alcohol. It is then allowed to stand over night, the precipitate of lead sulphate washed by decantation with 12% alcohol, and then filtered, ignited, and weighed. This method was used by Dixon Mann¹ and Legge and Goadby.²

The *molybdate method* has been used for the determination of small amounts of lead in mineral ores. Calcium salts interfere with the precipitation of lead molybdate. As these are always present in the ash of organic matter this method has never been applied to biological substances.

The *chromate method* was first recommended by Wm. Crookes³ in 1894 for estimating extremely small quantities of lead. Lead may be precipitated and weighed directly as lead chromate, or it may be estimated volumetrically by precipitating the lead with an excess of N/20 potassium bichromate solution and filtered, and the excess potassium bichromate titrated with N/50 thio-sulphate. The volumetric method was originated by Diehl.⁴ For the latest modification of this method, see below.

In Fairhall's *chromate method*⁵ he carried out his determinations by ashing the material in a muffle furnace at less than red heat, dissolving the ash completely in dilute hydrochloric acid with a few drops of tartaric acid, neutralizing this solution, acidifying slightly with hydrochloric acid and precipitating the lead as lead sulphide by saturation with hydrogen sulphide. The lead sulphide is washed with water, dissolved in concentrated nitric acid, the excess acid neutralized, the solution acidified with acetic acid and the lead precipitated as lead chromate by the addition of potassium chromate. The lead chromate is thor-

¹ Dixon Mann, *Forensic Medicine and Toxicology*, p. 496.

² Legge and Goadby, *Lead Poisoning and Lead Absorption*, 1912, p. 174.

³ Wm. Crookes, *Select Methods of Chemical Analysis*, London, Longmans, Green & Co., 1894, p. 318.

⁴ W. Diehl, *Zur Bestimmung des Bleies auf Mass-analytischem Wege*, *Ztschr. f. anal. Chem.*, 1880, vol. 19, 306.

⁵ L. T. Fairhall, *The Estimation of Minute Amounts of Lead in Biological Material*, *J.I.H.*, May, 1922, pp. 9-20.

oughly washed with water, dissolved in dilute hydrochloric acid, an excess of potassium iodide added and the free iodine titrated with .005 normal sodium thiosulphate solution.

(3) Electrolytic process

By this method the lead is separated as metallic lead at the cathode or as lead dioxide at the anode. The latter procedure is the more common. The determination of lead as metallic lead is usually undesirable as it is extremely difficult to dry metallic lead without oxidizing it.

For details of the various modifications of the procedure, see previous part on the electrolytic method.

III. Examination of blood for basophilia: Methods of staining

Danger of obscuring the stippling by the counterstain:

Schnitter¹, writing in the *Deutsch. med. Wchnschr.* of June, 1919, reports that none of his cases of lead poisoning were free from stippled cells and attributes the contradictory experience of other writers to their having obscured the stippling by the counterstain.

Various methods recommended

(a) Schnitter's method.²

Staining with azure of Manson's methylene blue alone.

(b) Oliver's method.³

Oliver considers that the best results are given by staining with a fluid composed of methylene blue, 2 grams; sodium bicarbonate, 12 grams; distilled water, 200 grams.*

The film of blood when dried is steeped in absolute alcohol or alcohol and ether for half an hour, then dried, afterwards steeped for one minute in the above solution, removed and washed in distilled water until the colour almost fades, when it is dried and is ready for examination.

(c) Ruelen's method.⁴

Fix in absolute alcohol 15 minutes. Stain 2 minutes. Wash in distilled water till the film becomes pale greenish.

Methylene blue (med. pur.)	1 gm.
Bicarbonate of soda,	6 gms.
Distilled water,	200 c.c.

(d) Post-vitam method.⁵

This method is referred to by Arthur Sellers, who speaks of it as efficient and simple and surprisingly little used. The formula as briefly quoted by Mr. Sellers is as follows:

"Make an ordinary wet-film preparation on a slide. Put a drop of 1 in 500 methylene blue on a cover glass. Drop onto the slide. Lute the edges."

A full description is in "*Traité du Sang*" by A. Gilbert and M. Weinberg, Paris, Baillière, p. 146.

(e) Method recommended by Legge and Goadby.⁶

"For all practical purposes, the best stain for detection of basophile granules in the erythrocytes is Wright's modification of Romanowski's stain."

¹ Schnitter, Early Diagnosis of Industrial Lead Poisoning by Means of Blood Tests. Abstracted in J.I.H., Dec., 1919, p. 126, supplement.

² Schnitter, Early Diagnosis of Industrial Lead Poisoning by Means of Blood Tests. Abstracted in J.I.H., Dec., 1919, p. 126, supplement.

³ Oliver, Lead Poisoning, in Diseases of Occupation and Vocational Hygiene, by Kober and Hanson, p. 83.

* Formula recommended by Dr. Glibert, of Brussels.

⁴ Quoted by Arthur Sellers, Blood Changes in Lead Workers, J.I.H., Feb., 1921, p. 364

⁵ Arthur Sellers, Blood Changes in Lead Workers, J.I.H., Feb., 1921, p. 366.

⁶ Legge and Goadby, Lead Poisoning and Lead Absorption, 1912, p. 179.

(f) *Hayhurst's method.*

Hayhurst recommends Harlow's solution. For explanation of this method see "Blood smears, their preparation and staining," in the Journal of the American Medical Association, 4. 12. 09, 53, No. 23, pp. 1909-1911.

(g) *Method used by the Division of Industrial Hygiene, Provincial Board of Health of Ontario.*

Harlow's method (with the exception that instead of using Ehrlich's medicinal methylene blue, which is difficult to obtain, methylene blue (Grübler) was substituted) was found to be exceedingly satisfactory and is so easy to use, and applicable to general hæmatology, that it is surprising that it is not more generally employed. The method is as follows:

The requisites are 2 wide-mouthed bottles of about 50 c.c. capacity in which a slide can stand upright and still allow of air being excluded by means of a cork: $\frac{1}{2}$ gramme water-soluble eosin (Grübler); $\frac{1}{2}$ gramme methylene (Grübler); 100 c.c. of absolute methyl alcohol (Merk).

The eosin is placed in the first bottle and 50 c.c. of alcohol added. It is not necessary to have the weight of eosin absolute; if there is any variance it is best to have the amount slightly in excess of the $\frac{1}{2}$ gramme. This is corked with a good rubber stopper. The same operation is carried out with the methylene blue in the second bottle. It may be found that the nuclei of the white cells do not stain clearly with the methylene blue. This generally means that the reaction is not sufficiently alkaline and the condition can be rectified by adding one drop of weak solution potassium hydrate in alcohol (no water to be introduced). This will serve to increase the alkalinity sufficiently to give good definition in the staining. Should it be found that the blue elements stain too deeply, the stain can be corrected again by adding to a few cubic centimeters of methyl alcohol a few drops of glacial acetic acid and using one drop of this solution. The test as to the proper reaction of the stain is the staining of the neutrophil granules of the polymorphonuclear leucocytes. These should stain a pale violet.

The slide is prepared in the ordinary way except that it is advisable to use a medium sized drop of blood and to place the drop in the centre of the slide. The slide with the drop of blood on it is held in the left hand and another slide is placed at an angle so that the drop of blood spreads out on the first slide in the acute angle between the two slides. Holding the second slide steady, the first slide is drawn away from it in the direction of the left hand for about one-eighth of an inch; then the first slide is pushed towards the right hand so that the blood film is evenly distributed over the half of the first slide. The film is allowed to dry in the air and immediately on drying can be placed in the eosin solution. The cork is at once returned to the bottle to exclude the air. The slide should be left in the eosin for at least 2 minutes; if, however, it is left longer no harm is done. The slide is then removed by the fingers from the first bottle and the edge gently touched to the bottle to drain off excess of eosin; it is then immediately, without washing, placed in the methylene blue solution in the second bottle. The same procedure is followed regarding the time of staining as in the case of the eosin solution. On removal of the slide from the methylene blue solution it should be retained in the fingers and swished about a few times in a tumbler or wide-mouthed vessel of ordinary tap water (if of a surface variety) or distilled water. Do not let the water from the tap run over the slide or it will wash the methylene

blue completely out. The slide is dried by placing between two sheets of blotting paper or filter paper and is ready for examination.

This method shows the granules in the leucocytes clearly and it also has been found to show up the basophile granules in the red blood corpuscles; these last appear as black dots in the body of the erythrocyte.

The advantages of the method are:

(1) The stain once made up, if protected from light and moisture, will last indefinitely (if the amount in the bottle becomes low more alcohol to bring it up to the original level should be added.)

(2) The desired effect to give clear definition can be obtained by changing the reaction of the methylene blue, as previously mentioned.

(3) The practical impossibility of over-staining if the reaction of the methylene blue solution is kept corrected.

The requirements for success are:

(1) A well-made blood stain.

(2) Protection of the solution from the light.

(3) No moisture whatever to be allowed to contaminate the solutions.

This involves exclusion of air at all times.

(h) *The thick drop method.*

L. Schwarz, writing in the *Zentralbl. f. Gewerbehyg.*,¹ claims that the detection of stippled cells is easier by the thick drop method than by the thin smear methods. The examination of ten fields in a thick drop preparation discloses more stippled cells than does the examination of 200 fields in an ordinary smear preparation.

The technic is as follows: The stain is Manson's borax methylene blue, made from 5 gm. borax in 100 c.c. boiling distilled water, plus 2 gm. methylene blue. This will keep for six weeks. For staining, thin it in a reagent glass until transparent. Stain the unfixed drop ten minutes. Basophilia may then be ruled out by examination of only 10 to 20 fields.

H. Engel,² however, considers that the stippling seen in the thick drop method is not the same as the recognized marking of basophilic degeneration and is probably an artifact due to the stain. He considers that the method is not reliable unless used with great caution.

IV. Liebermann's red corpuscle resistance test³

Hayhurst considers increase of the resistance quotient of the red blood corpuscles to hypotonic salt-solutions (0.45% NaCl) of more value in diagnosing lead poisoning than basophilia. It only applies, however, to acute cases.

Liebermann's test is as follows:

"Normal blood corpuscles will hæmolyze (lose their hæmoglobin) in 'plain water.' So also will they in hypotonic salt solutions of less than 0.5% strength. But the blood corpuscles in lead intoxication *become resistant*, so that in salt solutions as low as 0.4% they may not dissolve. Usually 0.45% is a convenient strength in which to try the test. In contrast to the effects of lead, mercury or phosphorus, which also affect the blood corpuscles, most toxic, debilitated or anæmic states cause a *lessened resistance* in the red corpuscles. To make this test, the patient must not be plainly suffering from signs of intoxication from alcohol, benzine or benzol.

¹ L. Schwarz, abstracted in J.I.H., Jan., 1922, p. 208, supplement.

² H. Engel, *Munchen med. Wchschr.*, April 28, 1922. Abstracted in J.I.H., Oct., 1922, p. 88, sup.

³ Described in Hayhurst, *Industrial Health Hazards and Occupational Diseases in Ohio*, 1915, pp. 386, 387.

(1) By means of a glass pipette, marked at point where one drop of blood comes, place a drop of fresh blood in 5 c.c. of a 0.5% NaCl solution contained in a centrifuge tube. Shake gently for two minutes, then add 5 c.c. of 1.5% NaCl and centrifuge quickly for a moment. The fluid above the compact mass of corpuscles in the bottom of the centrifuge tube will be practically colourless if the blood corpuscles are normal, or if they have been rendered hyper-resistant by the acute toxic effects of lead.

(3) To a second centrifuge tube containing 5 c.c. of a 0.45% NaCl solution, add another fresh drop of blood. Proceed as above. (Both performances may be done at the same time.) In this tube normal blood will show a distinct hæmolysis (reddening of the supernatant fluid after centrifuging), but in lead intoxication, the solution remains clear, showing that the corpuscles are resistant to the hæmolytic action of the hypotonic salt solution.

After a little practice the whole test requires less than three minutes, and, as explained, only two drops of blood. The various solutions must all be of the same temperature, that of the room, and an atomizer bulb should be used to blow out the drop of blood from the collecting pipette, since the CO₂ of the breath decreases the resistance. The above is a qualitative test only, but in the original method, definitive quantitative relationships can be determined, and stated by a resistance quotient, 'RQ.,' which is expressible in figures, so that the amount of intoxication may be shown."

V. Detection of lead on the bodily tissues

For detection at early period, Du Moulin of Grand has recourse to the expedient of dampening a small area of the suspect's skin with a 5% solution of the monosulphide of sodium. When positive this test is trustworthy.¹

Hayhurst² finds this test valuable where the workman is ignorant of the nature of the materials to which he is exposed. It is especially useful for painters who are not likely to be exposed to other metals which have black sulphides, such as mercury, copper, bismuth and nickel, which would cause a similar discoloration.

VI. Determination of strength of hand grip

The method used by Hayhurst³ in his examination of 100 painters is described by him as follows:

"This (*strength of hand grip*) was determined by a hand dynamometer of the Collin type, having a graduated reading from 0 to 200 upon the "échelle de traction." The instrument was standardized by obtaining the records of 55 men pursuing all manners of trades and avocations except those of lead exposure; the low reading was invariably over 150 in the weaker hand, the majority of normal men showing a strength of 160 to 230. To get uniformity of conditions, each person was required to stand erect with both arms horizontally outstretched while the hand holding the dynamometer was rather slowly contracted to maximal power, then released. Enough tests were made in each case to be certain maximal power was attained, then the highest reading accepted, gripping alternately with each hand."

1 W. H. Rand, Occupational Lead Poisoning, U.S. Bur. of Lab. Stats., Monthly Lab. Rev., Feb., 1921, p. 140.

2 Hayhurst, Industrial Health Hazards and Occupational Diseases in Ohio, 1915, p. 383.

3 Hayhurst, Critical Examination of 100 Painters for Evidences of Lead Poisoning. Am. Jour. Med. Sciences, June, 1914, No. 6, p. 788.

VII. Determination of strength of wrist extension

This Hayhurst¹ also determined by the dynamometer. He describes the technique as follows: "The subject was requested to sit in an armchair, first with hand passively flexed over forward end of the arm of the chair, when, with a wet towel folded up and placed on the dorsum of the hand to keep instrument from causing pressure pain to the hand, and also to prevent its slipping, the subject was asked to raise his hand up against the examiner's resistance on the dynamometer (active resistance). This gave one reading, the minimal for which was ascertained as not less than 30 with normal men. Secondly, the subject was requested to support his forearm on the arm of the chair, with hand extended free in the air, the wet towel applied as before, after which the examiner, with instrument in hand, forced the subject's hand to flex downward against his passive resistance. This gave a second reading, the minimal for which was ascertained as not less than 35 with normal men."

¹ Hayhurst, Critical Examination of 100 Painters for Evidences of Lead Poisoning, *Am. Jour. Med. Sciences*, June, 1914, No. 6, p. 788.

CHAPTER V

PREVENTION OF LEAD POISONING

The following chapter deals only with the main principles of prevention. Technical devices and specific measures applicable to individual processes will be found in the chapter on lead trades.

Recent development of the knowledge of lead poisoning has necessitated a change in the theory of the chief cause of poisoning. The doctrine that poisoning was usually caused by getting lead into the mouth has been replaced by the modern doctrine that the main source of poisoning is inhalation of lead dust by breathing. This change in thought necessitates drastic changes in the principles of prevention. The main objective of prevention can no longer be held to be the provision and use of adequate washing facilities, but is seen to be the prevention of the formation and circulation of dust. Thus not only is the focus of preventive work shifted, but also the burden of responsibility, which is no longer shared by employer and employee with the major portion falling to the employee, but is clearly placed mainly with the employer, whose province it is to order processes and install ventilation systems. The easy belief that "a workman poisons himself" has become almost obviously fallacious.

The main principles of prevention of poisoning fall under the following heads:

- (1) Use of substitutes for lead, or of the less soluble lead compounds (very briefly treated, as falling outside the scope of this work).
- (2) Prevention of the formation and circulation of dust and fumes.
 - (a) Covering of dry lead material and free use of water sprinkling where possible.
 - (b) Substitution of non-dust-producing processes for dust-producing ones.
 - (c) Prevention of fumes.
 - (d) Mechanical devices for preventing pollution of the air by lead dust or fumes.
 - (e) Prevention of accumulation of dust and prohibition of dry sweeping.
- (3) Special protection of the workers:
 - (a) Separation of dangerous processes from non-dangerous ones.
 - (b) Substitution of mechanical processes for hand processes.
 - (c) Protective clothing, masks, etc.
- (4) Medical supervision:
 - (a) Rejection of over-susceptibles; prohibition of women and children in certain processes; placement of employees with predisposing conditions; alternating work or reduction of hours of work on dangerous jobs.
 - (b) Regular medical supervision of all lead workers; attention to pre-symptoms (anæmia, etc.).
- (5) Personal cleanliness. Plant provisions.
 - (a) Washing facilities.
 - (b) Lockers for working clothes.

- (c) Eating rooms and prohibition of eating in work rooms.
- (d) Prohibition of smoking or chewing at work.
- (6) Personal habits:
 - (a) Food, breakfast, milk.
 - (b) Baths, hair, teeth, finger nails.
 - (c) Regular bowel movements.
- (7) Education of employees.
 - (a) General principles.
 - (b) Best methods.

1. Use of substitutes for lead or use of the less soluble lead compounds

(a) Use of substitutes

This is a question too intimately tied up with economic conditions and international trade policies to be within the scope of this chapter, which aims solely at indicating means of preventing injuries where lead is used. A few notes must therefore suffice.

(1) *Painting.*

The question of substitution has been considered chiefly in this trade, and with regard to substitutes for white lead and sulphate of lead. Intensive investigations have been conducted in France, Austria, Holland and England, and although the question has not been definitely answered, the present tendency of opinion is towards the belief that for interior painting which is not exposed to the weather, zinc paints are as good, if not better, than white lead paints, not only from the hygienic point of view, which was known, but from the commercial.

Zinc oxide or zinc sulphide or a combination of the two, or zinc and lithopone, are the substitutes most generally mentioned. Most of the many varieties of leadless paint appearing within recent years on the Austrian market contain iron, but some are compounded with zinc, aluminum or manganese. In the United States and Canada a great many leadless paints are in use, especially for cheaper grades of painting.

(2) *Textile trades—dyeing and weaving.*

Boulin and Leclerc de Pulligny¹ affirm that zinc chromate can replace lead chromate for dyeing thread and that a non-poisonous green for dyeing artificial flowers can be got by mixing zinc chromate and Prussian blue.

In dyeing and weaving silk in the United States, "tin, instead of lead, is used for weighing or giving body to the silk, and no lead dyes are used."²

(3) *Enameling porcelain.*

Bunge³ holds that a mixture of borax and barium salts is a perfect substitute for lead for enameling porcelain, etc.

(4) *Cutting of files.*

Sommerfeld⁴ says that tin can be used equally as well as lead for bedplates for cutting fine files and that the manufacturers' objection to it is based only on its higher cost.

¹ Boulin & Leclerc de Pulligny, *Hygiene Industrielle*, p. 443.

² Rogers & Vogt, 1913, quoted by W. H. Rand, *Occupational Lead Poisoning*, U.S. Bur. of Lab. Stats., Mon. Lab. Rev., Feb., 1921, p. 141.

³ Bunge, *Las Conquistas de la Higiene Social*, 1910, p. 276, quoted by W. H. Rand, Mon. Lab. Rev., Feb., 1921 p. 142.

⁴ Sommerfeld, quoted by W. H. Rand, *Occupational Lead Poisoning*, U.S. Bur. of Lab. Stats., Mon. Lab. Rev., Feb., 1921, p. 142, from a quotation in *Die Bleigefahr in Feilenhauer-Gewerbe*, p. 50.

(b) Use of the less soluble compounds

The sulphide is the least soluble of the lead compounds and then the sulphate. The basic carbonate (white lead) is probably the most soluble.

(1) *The pottery industry.*

Glaze for pottery is commonly made with the oxide or carbonate of lead. In England this lead has to be "fritted" (fired with silica or boric acid¹) in order to reduce its solubility, the standard of which is limited to 5 per cent. of the dry weight. General decrease of poisoning has resulted from this. In the United States the lead is not thus rendered insoluble and glazes sometimes contain up to 60 per cent. white lead. Regulations requiring the fritting of all lead glazes would be an easy means of reducing poisoning.

(2) *Painting.*

The sulphate of lead can often replace the carbonate.

2. Prevention of the formation and circulation of lead dust and fumes

(a) Covering of dry lead material and free use of water sprinkling where possible

A preliminary means of keeping dust out of the atmosphere lies in the use of air-tight receptacles for the storage and conveyance of lead in a dusty form. In many cases also it is possible to keep lead material damp while it is being handled, as, for instance, in the processes of lead smelting, where dust from furnace charges and discharges can be greatly diminished by free use of water sprinkling.

(b) Substitution of non-dust-producing processes for dust-producing ones

Concentration on this means of dust prevention should obviously be fruitful, since it goes to the root of the problem. The notable instances along these lines are substitution of wet methods of "rubbing down" in the painting industry and of wet fritting in the pottery industry.

(c) Prevention of fumes

In many instances in industry fumes are caused not from the heat of the molten lead, but from the stirring or agitating of hot lead.

Prevention, apart from the provision of exhaust ventilation at source of fumes, accordingly lies in care to keep lead below the fuming point where this is possible, and in realization of the fact that even when it is below this point fumes may be given off into the air if it is stirred or agitated.

(d) Mechanical devices for preventing pollution of the air by lead dust and fumes

This is a subject for the industrial engineer and covers the whole problem of artificial ventilation, including exhaust systems, hoods, air blasts, cabinets, screens and the like. The problem differs for each industry and each process. The methods and standards of efficient ventilation adopted by the different governments will be found in the part on legislation.

(e) Prevention of accumulation of dust and prohibition of dry sweeping

This is a somewhat elementary aspect of the dust prevention problem, but is one frequently ignored even in plants which have gone to great expense in installing elaborate systems of ventilation. Collection of lead scrap and shavings on the floor where they are trodden on and converted into dust, and accumulation of scraps of old lead in corners of rooms are common and persistent sources of dust. In many processes suitable receptacles have

¹ Oliver, Lead Poisoning, 1914, p. 71.

been devised for catching lead trimmings as they fall from machines or hand workers, and the provision of covered places for old lead waiting for retreatment is a simple measure.

Again, the good effects of provision of ingenious means for minimizing the formation of dust and preventing its circulation are nullified if small quantities of dust are either allowed to accumulate or stirred up by dry sweeping. Wet sweeping and wet dusting of rooms where lead processes are carried on are enforced by law in many countries, and in countries such as the United States and Canada, where more is left to the employer's own initiation, the hint conveyed by foreign legislation should not be ignored.

(f) Supplementary preventive measures for processes where dust cannot be completely eliminated

(a) Separation of dangerous processes from non-dangerous ones.

This comparatively simple precaution, requiring only appreciation of the danger of dust and fumes, and arrangement to limit the risk to the workers actually required for the process, is frequently ignored. Thus, for instance, in the printing trade, linotype machines, presenting hazards from the carbon monoxide from gas heaters and also from the lead scraps, are often placed in the same room as the compositors, who are thus exposed to a risk by no means inherent in their work.

(b) Substitution of mechanical processes for hand processes.

Even where the mechanical process is substituted without any health motive and merely in accordance with the general tendency to diminish the personal element in industry, it usually tends to reduce hazards as a whole by reduction of the workers involved. Where the health motive is present, the substitution of mechanical means of performing work which is bound to cause dust, should do much to reduce occupational sickness. Mechanical methods of sifting and crushing lead ores, mechanical cleaners for Dwight-Lloyd grates in the smelting industry, mechanical cleaners for linotype plungers in the printing industry, and, to take a very common instance, the use of vacuum cleaners instead of brooms, are all excellent from the hygienic point of view. The subject shows the folly of keeping the work of health prevention in industry in an airtight compartment by itself and regarding it as beginning and ending with the medical department. The effect of each process on the workers involved in it should be the business of both the plant physician and the mechanical engineer, and the latter should adopt as his objective the mastery of mechanical art not only to increase and improve production, but also to safeguard the workers involved.

(c) Protective clothing, masks, etc.

It is probable that there will always be in every lead plant of any size some workers who have to encounter dust or fumes. Protective body clothing is a supplementary precaution and usually a fairly easy one to carry out. The wearing of working clothes and the keeping of other clothes in lockers is a regulation which can be enforced. More important, however, is protection of the respiratory organs, and here there is both a technical difficulty in devising a suitable and practicable mask or respirator, especially in such a trade as painting, where dangers are coincidentally from lead and volatile substances, and a psychological difficulty in persuading workers to use the masks provided. Dr. Hamilton,¹ referring to the technical difficulties of the problem, says: "Neither

¹ Alice Hamilton, "Lead Poisoning in the Smelting and Refining of Lead," U.S. Bur. of Lab. Stats., Bull. No. 141, 1914, p. 16.

against dust nor against fumes can one trust to the protection of respirators. Anyone who has worked with filters and has tried to drive air through and keep dust back knows how thick a filter and how strong a force is required. It is impossible for a workman to get enough air through a really effective dust-filtering respirator."

Both Müller, the German engineer who accomplished great hygienic improvements, and the British factory inspection department, place greater reliance on muslin tied over the mouth and nose and washed daily.

It is probable, as hinted by Dr. Hamilton, that the psychological difficulties in persuading workers to wear masks are to some measure due to the discomfort, and would disappear if a mask both comfortable and efficient could be devised. The wearing of muslin is by no means the ideal solution. It certainly will not keep out all dust, still less fumes, and the necessity for frequent washing is a practical disadvantage. Moreover, in the painting trade, while the muslin might suffice for protection against lead, it is useless as a protection against the volatile substances. Against these a mask containing charcoal is required, and this would have to be activated frequently to get rid of the fumes absorbed into it. Thus we are confronted apparently with the need for painters of two masks, one against lead, which must be capable of washing, and one against fumes of volatile substances, which must contain charcoal, could not accordingly be washed, but must be activated frequently.

The need of guarding the respiratory organs against dust and fumes is so great that the problem of devising a suitable respirator should not be given up in despair. Comparatively little research has been reported on the subject and this is evidently one of the problems most calling for experiment and invention.

4. Medical supervision

- (a) Rejection of over-susceptibles, prohibition of women and children in certain processes, placement of employees with predisposing conditions, alternating work on dangerous jobs, reduction of hours of work on dangerous jobs

From the fact that the susceptibility of individuals to lead poisoning varies enormously, and also that certain conditions, such as pronounced anæmia and malnutrition, predispose to the disease, it follows that plants with lead processes should exercise special care in the selection and placement of applicants for work.

Initial physical examination is practised in many European and English plants, and it is used both as a basis for rejection and as a guide to placement.

Suggested standards of rejection.

The use of certain degrees of basophilic granulation as standards for rejection of lead workers is adopted chiefly in Austria and Germany, with, it is claimed, very striking effects in the restriction of lead poisoning. The most drastic view is that anyone showing 100 stippled cells per million should not be allowed to work in lead, the more common view being that 300 warrants suspension. For discussion of the applicability of such standards and the significance of basophilic granulation, see Chapter on Symptomatology, Signs and Diagnosis.

In one of the largest lead works in Newcastle-upon-Tyne a very full physical examination is made and applicants with albuminuria or whose blood-pressure is above 140 millimetres of mercury are rejected.¹

The somewhat general recommendations offered by Oliver are not specific enough to afford definite standards and are also somewhat in the nature of counsels of perfection. They are, however, useful in showing the main considerations

¹ Oliver, *Lead Poisoning*, 1914, p. 100.

to be borne in mind in engaging lead workers. He points out that poverty being a pre-disposing condition of lead poisoning, more poisoning may be expected if workers are drawn from notoriously poor classes. Men addicted to drink ought not to be selected since alcohol also predisposes to poisoning. Finally, "medical men whose function is to examine applicants for work in a lead factory do well not to accept anæmic persons, those whose glandular system is wrong, whose digestion is not normal, persons suffering from constipation, or who have kidney disease."¹

Legge and Goadby sum up the conditions which should lead to rejection as follows:

"Tubercular disease of every kind, idiopathic epilepsy, all forms of mental disease or weakness (hysteria, feeble-mindedness, and neurasthenia), obvious alcoholism, women who are pregnant or who give a history of repeated miscarriages prior to work in lead, persons with marked errors of refraction unless corrected by glasses, kidney diseases of all kinds, evidence of previous chronic saturnism, and bad oral sepsis."²

In conclusion, it need hardly be said that workers who have a history of several attacks of lead poisoning, perhaps after short exposures, pointing to undue susceptibility, should not be engaged for contact with lead.

Also, apart from the total prohibition of all women and children from the more dangerous processes, it would be wise to avoid engaging for any lead work either children or women in the child-bearing period, since the weight of evidence is on the side of those who consider that lead poisoning hinders successful delivery and that the condition of pregnancy predisposes to poisoning.

Prohibition of women and children in certain dangerous processes.

The prohibition of *women* in the most dangerous lead trades, which has had great effect in reducing the incidence of poisoning among women, is based on the view that women are fundamentally more susceptible to lead than men, and that lead poisoning is apt to produce sterility or to affect the viability of the offspring.

As regards *children*, the view that these are more susceptible to poisoning than grown people is almost universal.

Placement of employees with predisposing conditions.

In many plants, employees will be taken on who show slight symptoms of anæmia, tendency to digestive disorders, tendency to respiratory troubles, etc., such as do not disqualify them for all work in lead plants, but make it advisable for them not to be employed on specially dangerous jobs. Again, employees who have had one or more attacks of lead poisoning should in many cases be transferred to jobs necessitating less contact with lead. The plant physician who knows the conditions of the employees and should know in detail the relative hazards of different jobs should have a voice in the placement of new employees and power to effect transfers of old ones. Müller, whose principles of prevention are always exceedingly practical, and whose advice carries weight as it is based on the procedure he followed himself, makes a practice of placing the men in his smelting plant who had been poisoned, at work with the dressing, remelting and disilverizing kettles, where they would run little risk. Correlatively Müller advises selecting only the strongest workers as flue cleaners.

¹ Oliver, *Lead Poisoning*, 1914, p. 99.

² Legge and Goadby, *Lead Poisoning and Lead Absorption*, 1912, p. 226.

Alternating work on dangerous jobs and reduction of hours of work

This is a method of keeping down lead poisoning strongly recommended by Oliver and practised by Müller. Oliver, for instance, recommends that no flue cleaner in smelting works should work for more than two hours on end.

(b) Regular medical supervision of all lead workers

With the exception of the primary preventive measure of keeping down dust and fume, no one thing is as effective a preventive of poisoning as regular medical supervision, including frequent periodical examination. Oliver considers that for workers in dangerous processes this should take place as often as once a week.

As has been said elsewhere, lead poisoning is a cumulative disease, and is well advanced before marked symptoms appear. It is accordingly of the utmost importance to stop the disease in its early beginning and to have means of noting any significant gradual development of minor ailments. Further, the symptoms of chronic poisoning are easily confoundable with those of other diseases of the kidney, heart or digestive organs, and it is only by observing the occurrence of similar ailments in workers employed at similar work that the cause of the trouble can be learnt, a correct diagnosis made, and the apposite treatment applied.

The early symptoms of poisoning, such as anæmia, constipation and other apparently trifling ailments, do not figure largely among workers' "complaints," and are not connected in their minds with their occupation. It is only careful questioning by a physician who knows the possible significance of such conditions in lead workers, which will bring them to light.

An indirect advantage of medical inspection with the necessary maintenance of contact between the person with medical knowledge and the person exposed to danger is the opportunity for educating the employee in the precautions he should take. Supplementary education in the way of posters, notices, instruction from foremen, or other means, is valuable, but the physician has a definite prestige and also a unique opportunity to fit the precautions to the individual's especial needs, thus making them personal and practical.

The task of explaining to workers the chronic and often obscure nature of lead poisoning can be most easily performed when some minor ailments from which the man is suffering can be treated along the general preventive lines applicable to lead poisoning. A man is far more apt, for instance, to drink milk, wear a respirator, or adopt some other precaution, if he is advised to do so by a physician who knows his condition and can give advice as a corrective against specific personal ills.

5. Personal cleanliness: Plant provisions**(a) Washing facilities**

Until very recent years the need of provision of washing facilities was stressed at the expense of the more important and, logically, prior need for keeping down dust. In many plants there existed the somewhat absurd condition of adequate provision for baths and washing existing side by side with glaring negligence of any attempt to prevent contamination of the air with dust and fumes. The present change of emphasis does not, however, mean that washing facilities can be neglected. Lead can be carried to the mouth by dirty hands and may, according to some authorities, be absorbed through the unbroken skin. Hot water, soap and towels should be provided for all lead workers,

time should be allowed for their use, and the workers should be educated in their need.

(b) Lockers for non-working clothes; washing of working clothes

The need of the use of working clothes and the changing of these before going home may be judged from the fact that quantities of lead varying from 51.84 mgms. to 10128.24 mgms. were found after beating and emptying of pockets still to remain in painters' overalls and aprons which had been worn for a week.¹

Plant provision for washing working clothes is not commonly provided. That it would be a wise provision and that such washing should be performed as far as possible by mechanical means is apparent from the fact that Oliver reports more than one case of lead poisoning in women from the washing of their husband's overalls.

(c) Eating rooms and prohibition of eating in work rooms

The danger of swallowing lead by means of eating food in a lead-laden atmosphere or with lead-covered hands is an obvious one. Also the peculiar need of lead workers for nourishing food makes a hot meal greatly preferable to the less substantial food commonly brought by workers who eat in the work rooms. Further, the provision of a room where food may be eaten and the dinner hour spent makes possible the ventilating of work rooms.

(d) Prohibition of smoking and chewing

This prohibition is recommended by almost all the authorities on lead poisoning. It is forbidden by English and German law in lead smelting and casting, white lead, lead oxide, paint and dye, storage battery trades, and, in addition, by English law in file cutting and earthenware and china trades.

6. Personal habits

Without reviving the old fallacy that "a workman poisons himself," it is evident that some important precautions against poisoning are dependent on the workmen's co-operation and cannot be arbitrarily imposed upon them.

(a) Food, breakfast, milk

Lead when it reaches the stomach is less likely to be dissolved and to cause poisoning if digestion of proteid food is going on, and from this comes the special danger to lead workers of working on empty stomachs.

The taking of milk is especially valuable, since this protein tends more than any other to prevent the solvent action on lead of the hydrochloric acid of the gastric juice.*

(b) Personal cleanliness, hair, teeth, finger nails

Personal cleanliness is of importance from the point of view of all the three possible modes of entry of lead into the body. Where the person is covered with lead dust there will be some slight danger of breathing the dust, more of swallowing it, and possibly some of absorbing it through the skin, especially if there are any cuts or lesions. Oliver and others lay special stress on personal cleanliness and all the chief authorities recommend lead workers to take at least one full warm bath a week. Moustaches and beards are deprecated for lead workers. The teeth should be frequently cleaned, since lead is very apt to collect on the gums, and lead workers, as appears from the records of detailed physical examinations made, seem particularly subject to carious teeth. Finger nails should be kept short.

¹ Report of British Departmental Committee on Dangers in use of Lead in Painting of Buildings, Vol. III, Appendix pp. 39, 40.

* See Chapter I, Appendix A, p. 21.

Hayhurst mentions a useful expedient of proving to lead workers how much lead collects on the skin. He recommends the application of sodium sulphide (Na_2S , 5% solution) to the hands, arms and face, the result being black or brown discoloration in cases where lead is present.

(c) **Regular bowel movements**

Lead is frequently found in the urine and fæces of lead workers, and, as Oliver especially emphasizes, persons excreting lead are potential cases of lead poisoning since if at any time elimination of lead is checked, absorption may begin. Constipation is one of the most frequent early symptoms of poisoning. Workers should be informed of its possible significance and of the necessity of keeping all means of lead elimination in working order, if absorption of lead and thereby poisoning, is to be avoided.

7. Education of employees

(a) **General principles**

This is a very important part of prevention both as a means of ensuring that the purely personal precautions are taken and as a means of promoting appreciation of and *demand for* plant precautions.

On the face of it, it seems likely that a good deal of the opposition frequently encountered from employees and their neglect of provisions made for their safety, lies in the fact that it is not made clear to them that lead poisoning is most often chronic, producing obscure and often for years trifling ailments which are not, either by the men themselves or still unfortunately frequently by physicians, recognized as being connected with lead. Lead colic, though in reality *comparatively* rare, is in the minds of many the only form of lead poisoning. Thus workers who ignore precautions and happen not to suffer from colic, feel contemptuous of the precautions even while they may be suffering slightly, as for instance from anæmia, constipation and early kidney troubles, by reason of their negligence. Probably the most important part of propaganda lies in instructing employees in the characteristic action of lead, its tendency to remain in the body for years and its gradual and easily misinterpreted action on the body.

A second characteristic of lead which should be given greater publicity among workers is its results on offspring. It is in the nature of things impossible to *prove* that individual instances of miscarriages, still-births or infant mortality are due to the work of either parent in lead. But the conclusions come to by specialists from a study of collected instances should be made known to the workers—not as definite facts but as probabilities against which it is worth their while to take precautions.

(b) **Best methods**

As has been said, the best means of education lies in the personal interviews between plant physician and lead worker. Other means are the posting of notices stating the chief precautions either enforced or advised, the posting of the legal requirements of the industry, if any, and further the giving of publicity either by posted notices or spoken explanations of the reasons for any change in conditions of work which have as their basis health considerations.

For useful example of instructions to employees, see Appendix A.

APPENDIX A

FORM OF INSTRUCTION TO EMPLOYEES

NOTICE

Suggestions to Employees—How to Prevent Lead Poisoning

(1) All workers exposed to *lead dusts, lead fumes, lead solutions and lead compounds* are liable to *poisoning*. These poisons get into the body through the *nose* while breathing, or through the *mouth* when chewing, or swallowing, or wetting the lips.

(2) Do all you can to *keep down dust*. When sweeping or cleaning, always dampen with water, oil or wet sawdust. Where dust cannot be kept down, you must *wear a respirator*. This must be cleaned out at least once a day.

(3) *Eat breakfast before going to work*. Drink milk at meals, and if possible once between meals. *Do not eat meals in workroom*. Leave workroom at meal times.

(4) Keep *dirty fingers* out of your mouth, and off your food, and whatever goes into your mouth. *Wash hands, arms and face* with warm water and soap before eating, going to the toilet, or quitting the work-room. Clean your lips and rinse out your mouth before eating or drinking.

(5) A *moustache*, if worn, must be kept short. Do not wear a *beard*. Keep *finger nails* clean and cut short, also loose skin about the nails or hands.

(6) Do not chew *tobacco* or *gum* while at work. Avoid the use of intoxicants in any form, as they promote lead poisoning.

(7) Take a *full bath* with warm water and soap at least *twice a week*.

(8) You must wear *overalls and jumpers* while at work. Wear a cap if exposed to dust or fumes. *Do not wear your working clothes outside the working place*.

(9) *Keep your bowels moving* if possible once a day. *Report to your foreman* if you notice (1) loss of appetite, (2) poor sleep, (3) indigestion, (4) continual constipation, (5) vomiting, (6) pains in the stomach, (7) dizziness, (8) continual headache, or (9) weakness in arms, limbs or body.

*Note:—*Lead poisoning brings on paralysis of the wrists and arms, hardens the arteries, causes chronic diseases, and hastens old age and death. Some precautions rest with your employer, some with you. The above suggestions will help you to keep well.

CHAPTER VI

THE LEAD TRADES.

Lead is more widely used in industry than any other metal except iron. Oliver, dealing with present conditions in England, states that there are few industries with which lead is not directly or indirectly concerned.

Some years ago, a French physician, Layet, enumerated 111 industries in which it is used. Gilman Thompson says that there are at least 150 different trades in which workers are subject to lead poisoning.

The following is a very full list, made up from a variety of sources, of trades in which lead is used.

Alphabetical list of industries in which lead is used:

- Acetate of lead, manufacture of.
- Amber workers.
- Antimony alloys and extraction of antimony.
- Artificial flowers and leaves.
- Automobiles, manufacture of.
- Babbitting metal and solder.
- Batteries, storage, dry, manufacture of.
- Blacksmiths.
- Bookkeepers, using sealing wax.
- Boot and shoe industry.
- Bottle caps and capsules.
- Box and card factories.
- Brass foundries.
- Brass instruments, musical.
- Brass polishing.
- Brick kilns, brick and tile makers.
- Bronze workers.
- Brush makers.
- Bullets, manufacture of.
- Cable wire, manufacture of.
- Calico printing.
- Cameos, polishing of.
- Canning industry.
- Caps, metal for bottles, manufacture of.
- Car seals, manufacture of.
- Cash register, manufacture, tempering parts.
- Celluloid manufacture.
- Ceramic industry.
- Chauffeurs and mechanics.
- Chloride of lead.
- Chromate of lead.
- Chromo-lithography.
- Cloth singe-ers.
- Coaches, carriages and wagons, manufacture of.
- Coffin and coffin hardware, manufacture of.

Colours, manufacture of.
Commercial artists and engravers.
Compositors.
Cutlery industry.
Dentists' amalgams, mixing of.
Diamond cutting and setting of precious stones.
Dyeing and dye works.
Electric lamps, manufacture of.
Electric meters.
Electrotyping.
Embroidery, manufacture of.
Emery wheels, babbitting of.
Enamelling works.
Faucets, brass, polishing.
File cutting.
Flasks, manufacture of.
Flowers, artificial.
Friction match making.
Furniture factories, staining and polishing.
Furriers (lead for dyeing).
Garment workers (lead from weighted silk).
Gas and steam fitters.
Glass factories.
Glass polishing—use of putty powder.
Glaze mixing and dipping.
Glove and mitten manufacturing.
Hair, workers in.
Hardening and tempering steel magnets, piano wire, springs, files.
Harnessmaking.
House painting.
India-rubber industry.
Insulated wire, manufacture of.
Iron sanitary ware.
Jewels (paste), manufacture of.
Krems white.
Lace makers.
Laundresses.
Lead, casting of.
Lead, chromate, manufacture of.
Lead colours.
Lead mining.
Lead oxide, manufacture of.
Lead pipe and tubing, manufacture of.
Lead refining.
Lead, sheet, manufacture of.
Lead smelting.
Lead wire, manufacture of.
Leather industry.
Lettering on windows.
Linoleum, manufacture of.
Litharge.
Litho-transfer work.

Match manufacture (colouring the heads of matches).
Marble polishers.
Masonic white leather aprons.
Mining.
Mirror silvering, if backed with red lead.
Monotyping.
Nickel buffers and polishers.
Oil refining, handling lead pipe.
Oilcloth, manufacture of.
Organ builders.
Painters and commercial artists.
Paper hangers.
Paper mills.
Pearl, artificial, manufacture of.
Perfumes, manufacture of.
Petroleum industry, distillation and refining.
Pharmacists.
Photographing establishments, material, lead in retouching high lights.
Picture frames, metal, manufacture of.
Pins, manufacture of.
Playing cards, manufacture of.
Plumbers.
Plumbing fixtures, manufacture of.
Porcelain enamelled ware.
Potteries.
Printing.
Putty-making.
Red lead.
Roofers.
Roof tiling, manufacture of.
Rubber industry.
Sanitary ware, manufacture of.
Shot, manufacture of.
Silk weighting.
Silver metal.
Smelting lead.
Soldering.
Stamping designs on embroidery.
Stereotyping.
Stone and marble polishers.
Storage batteries, manufacture of.
Tanneries, tanning and leather dressing.
Telegraphists.
Telephone wire, manufacture of.
Tempering and hardening steel magnets, piano wire, etc.
Textile industries.
Textile printing.
Tiles, manufacture of.
Tin foil.
Tin ware and tin shops and tinning.
Transfer chromos.
Type foundries.

Type setters.
Varnish, manufacture and use of.
Wall paper, manufacture of.
Watch factories, lead for dials.
Waxed linen and napped cloth.
Weavers.
White felt hats, manufacture of—use of white lead.
White lead.
Window-lettering.
Wire tempering.
Wood staining and polishing.
Zinc ore smelting.

The most dangerous trades

Variations in different countries

The incidence of poisoning in the different trades varies to some extent in England, Europe and U.S.A., according to the variations in the volume and methods of production and the degree and kind of precautions taken. For instance, cheap tinware, dyeing and calico printing, file making by hand, and diamond polishing, which figure in either European or British literature, or both, as dangerous trades, are almost negligible in U.S.A.¹

English experience

According to English experience, from notification of lead poisoning for the years 1900-1918 inclusive,² the following trades, arranged in order, produced the greatest number of cases:

White lead (much the highest rate for the total period, but ranks low for the years of the war and had no case at all in 1918).

China and earthenware.

Coach building.

Smelting of metals.

Paint used in industries other than coach building and ship building.

Electric accumulators (storage batteries).

Paints and colours.

Ship building.

Plumbing and soldering.

Printing.

File cutting.

Red lead.

Tinning.

It is noteworthy, however, that the reports for 1919 and 1920 show a different incidence. For 1920 storage battery manufacture has the greatest number of cases of poisoning, then smelting of metals, then white lead; then china and earthenware.

¹ Alice Hamilton, Lead Poisoning in American Industry, J.I.H., May, 1919, p. 9.

² Gr. Br. Ann. Rep. Ch. Insp. Factories and Workshops, 1918.

Prussian experience

Wachter rates the chief lead trades in the following order of risk:

- White lead.
- Red lead.
- Shot and pipe manufacture.
- Painters.
- Lead and zinc smelters.
- Printers.

American experience

Dr. Hamilton considers that the most important lead industries in U.S.A. are lead mining (especially where the ore is not pure galena), lead smelting and refining, metallic lead trades, manufacture of white lead, potteries and tile works, enamelling sanitary ware, painters, storage battery manufacture, use of lead in rubber trades.

Hayhurst, in an investigation of lead poisoning cases in Ohio during 1913 and 1914,¹ found the greatest number of cases in the following industries, arranged in order:

- Electrical apparatus.
- Automobiles and parts.
- Pottery.
- Carriages, wagons and parts.
- Rubber goods.
- Lead oxides and carbonates.
- Paint and varnish manufacture.
- Painting and varnishing (non-manufacturing), house painting.
- Lead bars, pipes and sheets.
- Glass manufacture.
- Printing and publishing.

It should be noted here, however, that painting in factories, etc., was listed under the industry concerned.

Under the New York State physicians' reporting law, there were reported as occurring between September, 1911, to August, 1912 (inclusive), 125 cases of lead poisoning, of which the following trades had the greatest number of cases:²

Painting (in houses).....	51
Painting (in shops).....	22
Electric batteries.....	21
White lead.....	7

Conclusion on most dangerous lead trades in America

Gilman Thompson³ considers that "the most serious (trades) in point of view of the number of victims and gravity of the symptoms are the following: Lead smelting, making and handling lead carbonate, making electric accumulators; special printing and electrotyping processes, removing dry paint by sand papering or chiselling, and painting in general." To these should probably be added pottery and tile works.

1 Hayhurst, Industrial Health Hazards and Occupational Diseases in Ohio, 1915, p. 373, 374.
2 Gilman Thompson, The Occupational Diseases, 1914, p. 202.
3 Ibid, p. 200.

DETAILED DESCRIPTION OF DANGEROUS TRADES AND PROCESSES WITH SPECIAL PREVENTIVE MEASURES.

I. Lead smelting†

The chief danger is dust, and under dust is included the excessively fine suspension of poisonous lead salts, which make up the fumes from heated lead and lead ores.

Prevention

Bodily cleanliness is not nearly so important an element in protection as it is in the white lead, red lead, storage battery or pottery industries. This fact and its correlative that chief efforts should be directed at dust and fume removal is little realized by managers, etc., who are inclined to put undue responsibility on the worker for his own protection by cleanliness.

Main precautions to be taken

(1) Removal of dust and fumes by provision of hoods whenever dust and fumes are created, and by efficient mechanical exhaust ventilation. The New Jersey standard of 1912 for this latter is as follows:

"Sufficient suction head shall be maintained in each branch pipe within 15 inches of the hoods to raise 2 inches of water column in a U-shaped tube. Pressure to be taken by pressing tube attachment over small opening through pipe, commonly called static method. Tests to be made with all branches open and unobstructed."

(2) Prevention of dust by sprinkling of charges, etc.

(3) Subsidiary precautions are adequate provision of washing facilities and lunch rooms, medical supervision, restriction of continuous work at flue cleaning, and, for some processes, provision of helmets, gloves and working clothes.

Certain specific preventive measures will be mentioned in the following pages dealing with the different processes in detail. In addition, the readers should refer to the part on Legislation, containing the regulations adopted by New Jersey, 1914, Germany, 1905, France, 1908, and England, 1911.

Description of dangerous processes

The dangerous processes from the point of view of lead poisoning are broadly:

(1) Preparatory processes, such as crushing and screening the ore.

(2) Roasting and smelting processes, especially work at ore hearths, tapping and charging of blast furnaces, discharging from Huntington-Heberlein pots or Midvale converters, refining of dross and lead scrap.

(3) Cleaning of the flue-dust system (most dangerous of all).

(1) Crushing and screening

This, together with the subsidiary processes of transporting the ore when crushed, is apt to be exceedingly dusty work, likely to cause great accumulations of dust on floor and walls and clouds of fine dust in the air.

Prevention

Ordinary measures for keeping the buildings clean and removing accumulations of dust, cement floors, well-inclosed crushers, the installation of a spray

† Taken almost entirely, with minor changes in arrangements, etc., from "Lead Poisoning in the Smelting and Refining of Lead," by Dr. Alice Hamilton, U.S. Bur. of Lab. Stats., Bull. No. 141, 1914. Dr. Hamilton was indebted to H. B. Pulsifer, of the Armour Institute, Chicago, for some of the technical descriptions of the processes.

above the discharge to the travelling belt which carries the crushed ore to its next destination, facilities for cleanliness.

(2) **Roasting and smelting processes**

There are three groups of these:

(a) Roasting, pre-roasting and sintering, to drive off sulphur, antimony, arsenic or other volatile substances.

(b) Reduction or smelting proper.

(c) Refining processes, such as dressing, desilvering, etc., to free the lead from all traces of the other metals which may have been with it in the ore.

Ordinarily these three processes are quite distinct, a separate furnace or furnaces being used for each.

Types of furnaces in use

(a) **For preparatory roasting**

Hand-rabbed reverberatory furnaces, used to slight extent for roasting lead mattes.

Mechanical pre-roasters:

Godfrey furnace.

Holthoff furnace.

Wedge furnace.

These types of furnaces require scarcely any attention. During the natural running of the furnace it has only to be oiled, the fire kept up, the hopper above filled, and the roast taken away whenever a car is filled.

The furnaces *need* make scarcely any outside dust or fumes. The charging is usually mechanical and the discharge often takes place under a spray of water which eliminates all risk of dust. The work if done carelessly would be dangerous as there would be both fumes and dust containing oxide of lead.

Roasting and sintering furnaces:

Huntington-Heberlein pots } Essentially the same.

Midvale converters. }

Dwight-Lloyd machines, coming into general use.

In *Huntington-Heberlein pots and Midvale converters*, the charge to be roasted is placed in a huge cast-iron pot which has a false bottom. If the first layers of the charge are red-hot, the roasting begins the moment the blast is turned on beneath the grate; otherwise a fire must be started in the bottom before the charge is dumped in.

“As the blast is forced into the pot and the gaseous products of roasting must pass away from the top of the pot, it is necessary to provide a hood and an abundant draft in order to work about the pot at all. The charge in the pot usually has to be poked at intervals, thus necessitating opening the doors of the hood.”

Whether the pot is discharged by simply turning or by lifting and turning in mid-air, discharging causes clouds of fume and smoke. The breaking of the big cakes of sintered ore, partly by machinery and partly by hand, also causes copious dust.

Dust is the chief danger from these furnaces, but there are also fumes, as all pots leak when the wind is in the wrong direction.

European literature has records of a rate of lead poisoning as high as 23.2 per 100 employees among chargers of these pots and breakers of the roasted ore.

Preventive measures.

The chief proposals made are:

- Abolition of hand breaking of the ore, if practicable.
- Strict attention to cleanliness.
- Short periods of work with alternating jobs.
- Thorough use of water sprinkling.

In *Dwight-Lloyd machines* "the well-mixed and moistened charge is fed to a moving grate through the bottom of a hopper; the grate moves slowly forward bearing its 4 or 5 inch layer of mixture over the edge of a suction box, and under a flame playing down from above. The flame is drawn by suction down toward the charge, ignites it, and the gases pass downward into the suction box. During the passage of the ignited charge over the suction box, the chemical and physical work is accomplished so that at the end of the machine the cake, which breaks off and falls into the car, is both roasted and sintered. The empty grate passes down along an endless belt and up again to the starting point. Meanwhile the gases and fumes go from the suction box through the flue to the fan and then away to the big flues and bag house."

The Dwight-Lloyd process is considered the best hygienically, since the suction prevents the escape of most of the gas, fume or smoke.

Dangerous features are the cleaning of the grates (by chipping off bits of the charge which stick), and sulphur fumes and dust at the discharge. Grate cleaning can, however, be done mechanically and if the discharge falls outside the building and is played upon by a spray of water, there is no danger.

(b) **For smelting processes**

Open or Scotch hearths (ore hearths) are still used on a large scale. Hygienically these are exceedingly dangerous.

"The usual hearth is a cast-iron box, 4 feet long, 18 inches wide and 1 foot deep; it rests on a base or legs with its top about waist high. About the hearth box and resting on it is a three-sided water jacket, also of cast iron, while above is always an inner hood to catch most of the fume and in addition a broader, more spreading hood may be placed over both men and box.

Two men work the hearth; they throw on the fine ore and coke with a shovel; they stir the charge with pokers and toss the hot slag, first out onto the work plate or apron, then into a receptacle at one side (which may contain water) and drain out the melted lead into a pot at the other side. Almost without intermission the work goes on during the shift. Whenever the fire blazes up well through the smoothed-off mass, the latter must be stirred and restirred and thrown back, and more ore and coke added, and after a rest of a few seconds the whole operation must be repeated.

The blast comes into the hearth through a row of holes in the back just above the level of the lead, which practically fills the box. Before the lead quite overflows, one of the men banks the channel at one corner of the work apron and with his shovel pumps the lead up over the edge so that it will run down into the side pot. A little coal fire burns under this pot to keep the lead hot till enough has accumulated for the helper to mold it into 100-pound bars."

Hazards.

Smoke from the lead pot, the slag pot, and from the furnace itself are all rich in lead and often there are a number of hearths in a row, so that the air is cloudy with lead fumes.

Facilities for washing and for eating are usually non-existent and work is done at high pressure.

Precautions.

The primary problem is to discover the best possible means of keeping down dust and fume. A subsidiary and easy measure is to reduce the hours of work for ore-furnace men and to see that they have facilities for washing and a place free from dust and fumes where they can eat their food. Austria has greatly reduced the number of cases of poisoning for ore-hearth workers by reducing their hours of work.

Hand-rabbed reverberatory furnace, almost obsolete.

Blast furnace, in chief use.

"The blast furnace is a tall, narrow shaft filled with charge; at the base air is blown in and the fire rages, the charge reacts and melts, and settles on a bath of several layers while the gases, dust and fume pass up through the charge and out of the stack. From the crucible below the shaft the melted mass is tapped out according to whether the lower layer of lead or the upper layer of slag is to be removed. Slag comes out at the top of the crucible level and any matte comes with it, while lead is drawn off from the very bottom through a well which is sunk down to the bottom through the side of the crucible."

The two points of special danger about a blast furnace are *the charge or feed floor*, from which the charge of prepared ore is emptied into the furnace, often by shoveling, and *the tapping floor*, where, at different levels, the melting slag, matte and lead are drawn off.

The charge floor is hazardous when the charges are dry, when fumes escape from the charge doors and when fumes from the slag pot and matte kettle on the tapping floor below can come up through the floor or windows.

Preventive measures.

Sprinkling of the charge.

Artificial drafts to carry off fumes to the bag house.

The tapping floor

The danger is from fumes, not dust. The lead runs out at a low red or a bright red heat, fuming always more or less, although the fumes being much less conspicuous than those from slag and matte, are apt to be ignored by the workers.

The Annual Report, Chief Inspector of Factories and Workshops, Great Britain, for 1900, quotes an analysis of fumes on tapping floors, showing that a man might there breathe 7.38 grains of lead (0.478 g.) in 8 hours.

Preventive measures.

The very successful measures taken by Müller, in his plant, were as follows:

The tapping floor was in a well-inclosed and very clean building with white-washed walls and complete artificial ventilation. "Over the lead tap and the tap for slag and matte a large hood was fitted, the edges of which came to within 3 feet of the floor. This was connected with the flue system and there was a strong suction in the shaft. A window in this hood allowed the workman to open and close the top with a long-handled rod. The workman was not allowed to wheel away lead pot, slag or matte till the contents had cooled to at least a dull red heat."

(c) For refining processes*Softening and refining reverberatory furnaces:*

In the modern plant the worker has merely to place the bar of lead on a conveyor or run the already molten lead into the furnace through a pipe or spout. The furnaces are emptied through tapping the lead out or by a siphon. More or less fume escapes at the time of drawing drosses and skims and sometimes at the lead pot. The red-hot skim also fumes after it has been drawn out.

Drossing, remelting and desilvering kettles:

Lead may be charged into the kettles by hand or in huge slugs lifted by power; most frequently the already molten lead is run in through spouts or poured in from a lead pot. The temperature does not need to reach fuming point. Desilvering usually is practically free from fumes or dust, the only danger being the lead which clings to the men's hands and is pure metallic lead or the oxide. Oliver says that it is rare to find lead poisoning in a desilverer, and Müller made a practice of placing men who had had lead poisoning at this job.

By-product or residue furnaces:

The material, usually solid, is dumped into a hopper over the furnace and then let into the furnace through the roof. It is not unusual to shovel the charge in through a side door. The furnace is emptied by tapping out into slag pots, skimming through side doors or letting the lead out through a well.

There may be an enormous amount of fume. (There is also danger from arsenic fumes and dust.)

Retorting and cupelling furnaces:

An important link in the recovery of gold and silver. "The rich amalgam of zinc and lead in chunks is dropped into the retorts in the Fabre du Faure tilting furnace and the condensers sealed on the neck of the retort. At the close of the distillation, when the zinc has been volatilised, the condenser is removed, and the rich lead poured out and wheeled to the cupelling furnace, into which it is poured. From the cupels the doré, silver and gold are recovered, the lead is oxidized to litharge and the arsenic and antimony are lost in the fume."

"There is a process of drawing out the last remaining zinc from the lead by a blast of dry, super-heated steam. This is considered distinctly dangerous. Lead oxide and zinc oxide are formed and at the same time atomized, and if the blast is too strong and the hooding insufficient, they are driven out into the room in the form of dust."

Müller believes that if precautions are not taken to prevent the escape of fumes, work at retorts and cupels may be as bad as at blast furnaces. An additional danger is the dust caused by breaking up, sometimes by hand, the cakes of litharge from the cupels.

Liquidating furnaces:

Few in number, small and simply worked. Bars of lead are thrown in by hand or on a paddle, and the lead drips away from the sump into a kettle. The residue, small in amount, is scraped from the hearth by hand.

(3) Flue-dust system

Through the process of roasting and smelting, fumes are evolved which contain enough volatile lead compounds, chiefly oxides and sulphates, to make

their recovery desirable. For this purpose an elaborate flue dust system is provided.

Flue dust is a bluish black powder, light and fluffy, consisting chiefly of the oxides and sulphate of lead and also, sometimes, of arsenic.

Usually steel flues pass from the roasters and blast furnaces to end in great brick flues and these in turn pass on to the bag house. "Steel flues are usually furnished with some arrangement for allowing the heavier flue dust to be removed. This can be done through windows in the flues which permit the cleaners to insert rakes to scrape out the dust, or, if the flue is very large, permit him to enter and shovel it out. A better arrangement is to have hoppers at intervals along the flue, when it is only necessary to open the sliding grate at the bottom of the hopper and let the dust fall into a car below. If a canvas chute is used from hopper to car, there need be little dust in emptying the hopper."

Brick flues are always entered and the dust shovelled out.

In bag houses the bags are emptied either by shaking by hand or, better, by mechanical means. Reversing the current of air and causing a vacuum which makes the bag collapse is the best way.

A bag house should always be divided into separate compartments, not only because of the danger from fire, but also because if the bags are all in one room the whole house must be shut off once every day when they are shaken, and this means that the whole draft system is out of commission during that time.

Good bag house system in the U.S. smelter at Midvale

"There is a very large bag house here with some unusual features. In the first place, the SO_3 in the fumes is neutralized by mixture with volatilized zinc oxide, forming zinc sulphate. The process is patented by this company. Another scheme for neutralizing the SO_3 is by introducing lime into the flues. This also is patented. The construction of the tunnels is different from that in any other plant. Instead of having simple openings in the roof of the tunnel through which the dust from the bags falls, each opening is connected with a hopper which catches the dust and discharges it into a screw conveyer. The tunnels are all open and carts could be seen standing at the discharge of the screw conveyers near the doors. The men are not obliged to go into the tunnel at all. Bags are shaken by reversing the current and causing a vacuum in one of the twelve compartments of the bag house at a time. Bag repairing must be done at least once a day, but never until the compartment has been shut off and the windows opened. The big flues are cleaned once in 6 months by flushing out. The workman opens a hole in the top of the flue and a vent at the bottom leading to a large pipe; then he directs the water from a hose into the flue, and the dust is washed out into a settling tank."

The company also provides overalls, helmets and gloves, a bath house with hot water, soap and towels, separate lockers for street clothes and working clothes and a well-heated lunch room.

The emptying of the bag-house tunnels, in which this dust is caught, may be done either by burning it first in the tunnel, making it cake or sinter, or by shovelling out.

There is great diversity of opinion as to the advisability of burning flue dust and the feasibility of sprinkling it. The work is very dangerous. Müller advises burning the dust, employing only the strongest workers for the job, taking every precaution to protect them and giving them short shifts. Oliver holds that no flue cleaner should work more than two hours on end.

(4) Manufacture of sublimed white lead

This is sometimes done in smelting and refining plants and is exceedingly dangerous, involving work in connection with the three worst features of lead smelting, *i.e.*, ore hearth, blast furnace and bag house.

Summary of most dangerous processes

Cleaning of flues and bag houses; work at ore hearths; tapping and charging of blast furnaces; making of sublimed white lead; discharging from Huntington-Heberlein pots, or Midvale converters; refining of dross and lead scrap.

II. Lead refining

Essentially the same processes are involved as for lead smelting, *q.v.* Although the lead fumes are apt to be less in refineries than in smelters, there is probably more lead poisoning, as a great deal of dusty scrap and dross is worked up and the whole industry is apt to be less well managed.

III. Manufacture of white lead or basic lead carbonate*

Old Dutch process (in chief use)

"The making of white lead or basic lead carbonate is a process involving much time and danger. It is conducted in a closed chamber and requires about three and a half months. The chamber is filled with layers of earthen jars superimposed with layers of boards, with tan bark and sometimes horse dung between. Strips or 'buckles' of metallic lead are laid across the mouths of the jars, which are filled with dilute acetic acid. The acid vapor arising converts the lead to an acetate, which is then made into a basic carbonate by the carbonic acid gas and warmth arising from the fermentation of the tan bark. The temperature of the fermentation chamber may reach as high as 140°-150° F. This process is known as the 'Dutch process,' and the layer of jars and bark as the 'blue bed.' At the conclusion of the process, which lasts eight to ten weeks, the 'blue beds,' now become 'white beds,' are found to contain the basic carbonate of lead in dusty masses adherent to what remains of the corroded metal. The carbonate is sprayed with water to lessen the dust, taken out, washed and ground to a pulp, and then placed in jars on shelves in rooms called 'stoves.' The stoves are heated to 70° C., or more, for 48 hours, or sometimes for as long as a week, to dry the preparation. Uncorroded fragments of lead from the beds are sifted out and either returned for further treatment with acetic acid or remelted. Handling these dusty fragments is a very hazardous occupation. The carbonate is ground, washed and allowed to settle down in large vats. After grinding and drying the finished product is dumped into barrels. The emptying of the stoves to remove the dry carbonate, the packing of it in barrels after regrinding, and final mixing with oil to make paint are all dusty and dangerous processes."

There are various alternative processes, such as the Chamber process and the Carter process, for the manufacture of the same product, but the principle is the same in all.

Preventive measures

Of primary importance are an efficient system of dust removal and strict personal cleanliness. Workers should be supplied with clean overalls weekly.

* Description of the Old Dutch process is taken from "The Occupational Diseases," by Gilman Thompson 1914, pp. 209-211.

IV. Manufacture of storage batteries

Hayhurst says that except for the manufacture of oxides and salts of lead there is no industry that requires greater precautions against lead poisoning than the manufacture of storage batteries. The trade is considered very dangerous in both England and Germany, and the rate of lead poisoning found by Dr. Hamilton in five large American factories during 1913, nearly 18 per 100 employees, exceeds that termed bad in Germany a quarter of a century ago.

At the same time both English and American experience seems to show that the proportion of severe cases is lower than that for other industries.

Description of the processes†

As cases of lead poisoning have been known to occur among workers in every process of the industry, all are briefly described.

Casting or molding

The molder stands close to the casting kettles, skimming dross and ladling lead into molds. The dross he usually throws on the floor, where it is trodden into dust.

The danger in the casting room is in proportion to the number of kettles, the presence or absence of hoods with exhausts over the kettles, the care in handling the dross and the separation of the work from other dangerous processes. There also may be danger of arsenic fumes if the lead contains arsenic. (It has been stated that no antimonial lead in U.S.A. is quite free from arsenic.)

Trimming grids

Grids are often cast in pairs and then sawn apart and trimmed. In the case of large grids, the "lug," or handle has to be burned onto the body. The Planté plate is cast somewhat differently and the worker is exposed to oxide dust.

Mixing the oxides for Faure plates

The trimmed grids are next covered with paste, the essential elements of which are the oxides of lead. Dilute sulphuric acid, and probably in some cases ammonia, is used to moisten the oxides. The mixing of the oxides presents an obvious dust hazard. The safest way is to have the paste made in a special room and supplied to the pasters.

Pasting plates

The tables at which pasters work should be covered with glass with a raised rim to prevent paste dropping to the floor. Some pasters wear no gloves and knead the paste into the grids with their hands. There is an obvious lead dust hazard, whether litharge paste or red lead paste is used.

Drying pasted plates

Large plates have to be dried before they are "formed," or "pickled." The men who take them from and to the racks have a very dusty job.

Forming, or pickling

The forming room is full of troughs of dilute sulphuric acid, in which are immersed large numbers of plates, connected by a copper bar. A current of electricity is sent through the plates and then they are formed. Fumes of sulphuric acid are given off.

When the formed plates are taken from the acids they are washed in various solutions.

† Taken from "Lead Poisoning in the Manufacture of Storage Batteries," by Dr. Hamilton, U.S. Bur. of Lab. Stats., 1915, Bull. No. 165.

Assembling and lead burning

Formed plates are grouped and fastened together by lead strips. Pure lead is used instead of ordinary solder, and heat is applied by means of an oxyhydrogen flame. Trimming and other work is frequently done in the assembling room and cause dust from the dry oxides. Lead burning is considered by the British and Germans particularly dangerous work. British reports show more lead poisoning among these workers than among any others in electric accumulator factories, but experience in the States is contradictory to this. This may be explained by the fact that the British use a pure oxyhydrogen flame, while the Americans use hydrogen mixed with atmospheric air, in which the oxygen is greatly diluted.

Finishing (making up the batteries)

The plates are charged, then placed in cells filled with acid, and then covers and outer connectors fastened on. The only lead work here is making the connectors on the outside of the battery. This is essentially the same as lead burning for it is done with pure lead and the oxyhydrogen flame.

Small plates are placed in hard-rubber containers.

Medium plates are placed in glass containers.

Large plates are placed in wooden boxes lined with sheet lead.

The making of this lining is similar to lead burning, the lead sheets being welded together by an oxyhydrogen flame. In making the largest sizes the workman has to put his head inside the container.

Source of danger in the different processes

In casting and molding, the danger is from fumes and possible particles of metallic lead.

In trimming, polishing and filing the molded grid, only metallic dust (less dangerous than lead fumes or oxide dust) is encountered.

Mixing the oxides, making the paste and applying the paste expose the men to red lead and litharge. The first two of these can be made safe by enclosing the dump for dry powder and the machines. In applying the paste danger can be minimized by keeping the paste wet and the rooms clean.

Assembling, lead burning and finishing expose the worker to oxide dust and to fumes from the use of the oxyhydrogen flame on pure lead.

Order of danger

Mixing.

Pasting.

Assembling and burning.

Casting and trimming (much less dangerous).

Preventive measures.

These are chiefly artificial ventilation for removal of fumes and dust, methods for securing strict personal cleanliness, and medical supervision.

The regulations in force in Germany are concerned with the following points:

Adequate ventilation; floors impervious to water, not made of wood or linoleum or soft cement in any room in which lead is handled. Walls smooth, covered with washable paint or whitewashed once a year.

Casting, polishing and pasting, each in a separate room.

Hoods over melting pot and over lead burning. No lead dust to be allowed to escape in the course of cutting and polishing.

Hoods with exhaust over paste mixing and pasting.

Floors to be cleaned with water twice a day.

Separate lunch room, separate dressing and wash rooms, washing to be compulsory, one bath a week. Work clothes to be provided consisting of a full suit and cap. Soap, towels and brushes to be provided.

No women or minors to be employed.

Pasters and mixers to be allowed to work only eight hours a day with an hour and a half for lunch, or six continuous hours. Medical inspection once a month.

V. The painting industry

By general agreement, painting ranks highest in the dangerous lead trades, since in all countries there are greater numbers employed in the various kinds of painting than in any other single trade, and no community, no matter how small, is without some painters. The actual *relative* rank of painting in regard to danger of poisoning is, however, difficult to assess. On the one hand, there are other considerations in addition to that of numbers which tend to give painting great prominence as a dangerous lead trade. In the first place, it is largely skilled work, and therefore men are apt to remain at it and thus to be long exposed to the chance of incurring poisoning; in the second, poisoning from the volatile substances of paint is liable to be mistaken for poisoning from the lead pigment and thus falsely to increase the statistics of lead poisoning; and further, the dangers of lead in painting being by this time proverbial, the likelihood of cases being missed through incorrect diagnosis is less than in other trades.

On the other hand, cases occurring among painters working in factories and plants are often incorrectly attributed to the industry concerned where the painter may be misleadingly ranked as "labourer," and at the same time there is greater likelihood of cases of lead poisoning among painters being unreported and therefore lost, statistically speaking, owing to the difficulty of subjecting the trade to regulations imposed on other lead industries. Thus in Great Britain house painting does not come under the Factory Acts requiring that cases of lead poisoning be reported.

While the above facts must be kept in mind for the correct interpretation of statistics of lead poisoning among painters, figures are available which are at least suggestive.

That the relative mortality of painters from lead poisoning is exceedingly high may be judged from British death certificates in which lead poisoning is cited as the cause of death. An analysis of those for the years 1900-1913 inclusive shows that there were 427 deaths from this cause among house painters as compared with 421 among occupations under the jurisdiction of the Factory Acts, including such admittedly dangerous trades as the manufacture of white lead and other lead compounds, the manufacture of pottery, lead smelting and others.¹

American mortality statistics confirm this, and J. B. Andrews found in a study of 60 fatal cases of lead poisoning that 40 had been painters.

As regards morbidity, it is exceedingly hard to get figures showing the relative danger of painting as compared with other trades. For American experience the following instance is indicative.

Under the New York State Physicians' Reporting Law, 125 cases of lead poisoning were reported between October 1, 1911, and September 30, 1912, of which 73 were among painters.

¹ Report of British Departmental Committee on the Danger in the Use of Lead in the Painting of Buildings, 1914, Reprinted by U.S. Bur. of Lab. Statistics, Bull. No. 188, March, 1916.

Difficulty of safeguarding the painting industry

The difficulties are greater than in almost any other lead industry, since it is obviously impossible to prevent all dust by exhaust ventilation and it is difficult to provide washing facilities in new houses and buildings in the course of construction.

The general cause of danger in painting—lead dust, not lead fumes

For many years it was generally thought that both lead and dust fumes were hazards of the painting industry, the danger from fumes being probably assumed from the fact that painters, in common with other people, experience sensations of choking and oppression in freshly painted rooms.

Within recent years, experiments made by Professor Baly, Liverpool, Professor Armstrong, of London, and Mr. Klein, London, Sir Kenneth Goadby, Dr. Dobbie, the principal chemist of the British Government Laboratories, and others, point to the conclusions that there are no lead vapours from fresh paint. The air from freshly painted surfaces contains lead but not as vapour; the lead is in the form of minute solid particles and in quantities so small as to be negligible. The ill effects of fumes from fresh paint are attributed to the liquid vehicles, especially turpentine, *not* to the lead. Experiments dealing with the effects of the liquid vehicles of paint are referred to in the Report of the British Departmental Committee on the Danger in the Use of Lead in the Painting of Buildings, and in Appendices III and IV to that report, and some of Goadby's experiments are reproduced in Appendix A to this chapter. There is also an article on lead emissions from fresh paint by Dr. Herman in Bull. Acad. Med. Belg., July, 1914, the abstract of which in the Journal of Industrial Hygiene, Dec., 1919, p. 126 Sup., is reproduced in Appendix B for convenience of reference.

The dangerous compounds in painting¹

Paint is composed of pigment and the liquid vehicle (linseed oil, turpentine, petroleum spirits, benzine, etc.) either of which may be harmful. The present study being concerned solely with lead and its effects, the possible poisoning from the liquid vehicle or from pigment other than lead has not been considered.

The lead salts used as pigment are alternatively as follows:

- (1) White lead or basic carbonate of lead (approximately $2\text{PbCO}_3(\text{OH})_2$).
- (2) Sublimed white lead, or basic lead sulphate (approximately $2\text{PbSO}_4\text{PbO}$, the proportion of oxide being variable).
- (3) Red lead and orange mineral (Pb_3O_4 or $2\text{PbO}\cdot\text{PbO}_2$).
- (4) Chrome yellow or lead chromate (PbCrO_4).
- (5) Chrome green, or Brunswick or Prussian green, a mixture of yellow chromate with Prussian blue.

Of these the first is by far the most general, especially for interior work, but the second, lead sulphate (sublimed white lead or basic lead sulphate) has come into increasing use of late years, sometimes as a substitute for white lead, sometimes in combination with it. On certain parts of structural iron and of bridges and railway cars, red lead is considered essential by most. Orange mineral is used largely in wagon painting, chrome yellow for tinting in house painting and on farm wagons and railway coaches, chrome green for window shutters.

¹ Taken chiefly from "Hygiene of the Painters' Trade," by Dr. Alice Hamilton, U.S. Bur. of Lab. Statistics, 1913, Bull. No. 120.

Relative dangers

For some time most authorities considered lead sulphate as harmless, but recent investigations seem to show the contrary, and its toxicity has been accepted by almost all scientists, with variations, however, in the degree of danger they attribute to it. In any case, they are all agreed that it is less harmful than lead carbonate.

Cheap paints less harmful

Cheap paints contain little or often no lead. It is for this reason that poisoning is most often found among skilled workers in high-class work.

The dangerous classes of painting

Dr. Hamilton rates the various classes of painting in the following order of danger:

- (1) Ship painting—much red and white lead used on work in confined quarters and on piece work system.
- (2) House painting.
- (3) Wagon and carriage painting. This may be quite safe or very dangerous.
- (4) Automobile painting.

Other classes with much less risk and that varying according to the amount (if any) of lead in the paint, etc., are outdoor painting, sign-painting, railway car painting, agricultural implements, furniture, picture frames, mouldings, etc.

The dangerous processes

(a) English view:

Dr. Legge (in the Report of the Departmental Committee on the Danger in the Use of Lead in the Painting of Buildings) ranks the chief sources of lead poisoning among house painters in the following order of importance:

- (1) Dust from mixing dry white lead with oil.
- (2) Dust arising from paint which has dried on overalls.
- (3) Dust from sandpapering one coat of paint before applying another.
- (4) Contamination of food by unwashed hands.
- (5) Possibly the fumes from burning off old paint.

The witnesses (master house painters, members of national societies of painters, chemists and other experts), called before the Committee agreed, however, that the most prolific source of dust in the painting business is in the "dry rubbing down" of painted surfaces, either (a) the dry rubbing down of old paint work in preparation for the application of fresh coats of paint, or (b) the dry rubbing down of newly painted surfaces, to prepare them for the application of a second coat of paint. For a British Factory Inspection report on the amounts of lead in the air during the sandpapering of lead-painted surfaces, *see* Appendix C.

Actual figures for the amount of dust accumulated in overalls was investigated for the Committee referred to above, with the result that *after* removal of dust from pockets and beating of the overalls, amounts varying from 51.84 mgms. to 10128.24 mgms. were found still to remain in the garments.¹

Oliver also refers to cases of lead poisoning in his experience by women engaged in washing painters' overalls.

(b) Experience in the States.

Dangers from mixing dry lead salts with oil or paint are negligible in U.S.A., since red lead is rarely handled dry by painters; white lead hardly ever.

¹ For full figures see Appendix D.

Dry sandpapering is probably the chief danger. Hayhurst, speaking of his experience in Ohio, says, "If the rubbing down of lead paste 'fillers' and the dry sandpapering of painted surfaces were done away with, about nine-tenths of all cases of lead poisoning, at least as they are reported in the State of Ohio, would be stopped forthwith."

The alternative method of rubbing with pumice stone and water is much rarer in U.S.A. than in Europe.

Dr. Harris, of New York, mentions a substitute for sandpaper which has recently come into use, namely, steel or mineral wool. He considers that the use of this wool adds to the effects of the lead dust the irritating effects of the metallic or glass particles.¹

Chipping of old paint is very dangerous.

Burning off old paint is sometimes cited as a dangerous process on account of the fumes produced, but it seems to be generally agreed that the heat would not ordinarily be sufficient to volatilize the lead.

Paint dust on the floor, drop cloths and overalls is a danger. As regards the drop cloths, Dr. Hamilton refers to the raising of dust through the shaking of these cloths and the continual slight stirring up as they are walked on, etc.

Danger from ingestion of paint, either from unwashed hands or from food and tobacco contaminated with paint, is the most commonly recognized, but by no means the greatest, of the hazards of the trade. The evidence of the witnesses heard by the British Committee showed that, at any rate up to a few years ago, the painters themselves, and to a less extent the scientific experts, placed danger from dust inhalation below dangers arising from lack of personal cleanliness and either explicitly or implicitly blamed the worker who contracted poisoning for uncleanness. "If a man has painters' colic, it is to a great extent his own fault, generally speaking,"² is a specific expression of what was and *still is* a very general feeling.

The modern English view on this point—and by no means the most extreme view—may be summed up by Dr. Legge's words, "My feelings about that, *i.e.*, provision for cleanliness, always is this, that unless you can go to the fountain head of the mischief, the dust, and stop that, you are not going to secure much improvement by all the personal cleanliness in the world."³

The modern American view is identical, and Dr. Hamilton deplores⁴ the widespread superstition among plant managers, etc., that their share in prevention has been done when facilities for washing are installed.

A further little-recognized danger of lead poisoning for the painter lies in his habit of holding putty (a lead product) in his hand as he smears it over cracks, etc.

Spray method of painting

Painting by spraying machines is a fairly recent development and there has been as yet little or no scientific investigation into the relative danger of the spray or hand brush method, except that of Dr. Noble Sharpe, reported recently in the *Journal of Industrial Hygiene*.⁵ Dr. Sharpe showed that with lead or other dangerous pigment, there would be great likelihood of absorption in the spraying of large surfaces such as walls and ceilings. The spray-painting of

¹ Harris, "A Clinical Study of the Frequency of Lead, Turpentine and Benzine Poisoning in 400 Painters," N.Y. City Dept. of Health, 1918, p. 7.

² Minority Report of the Report of the British Departmental Committee on the Danger in the Use of Lead in the Painting of Buildings, Reprinted by the U.S. Bur. of Lab. Statistics, Bull. No. 188, p. 177.

³ *Ibid.*, p. 158.

⁴ Alice Hamilton, *Lead Poisoning in American Industry*, J.I.H., May, 1919, pp. 15, 16.

⁵ N. C. Sharpe, Report of an Investigation to Determine the Hazard to the Health of Operators using the Spraying Machine for Painting: The Risk of Lead Poisoning, J.I.H., April 1922, pp. 378-386.

objects capable of being enclosed in a cabinet should, however, be perfectly safe provided the cabinet be equipped with sufficient suction.

Special preventive measure

The New York Department of Labour, in a Bulletin issued in 1917 and entitled "Hoods for Removing Dust, Fumes and Gases," gives the following description of a hood for use with spraying machines:

"Such work should be performed with an enclosed hood varying in size according to the size of the article to be coated. The conical portion of the hood should be in the direction of the flow from the spray brush, with a pipe leading from it of an area not less than one-sixteenth the cross sectional area of the hood, with a minimum air velocity of 5,800 feet per minute, corresponding to two inches static suction. It is wise when providing a fan in the pipe, to place it at a point as remote from the hood as possible, or arrange to readily detach the fan, in order to clean it of material which attaches itself to the blades.

If the pressure is too great from the spray brush, it may be necessary to increase the static suction, to place a baffle at some point within the hood to prevent deflection of the stream of spray, or to provide a slotted pipe within the enclosed hood, placed near roof and front end of hood, connected to the exhaust fan. This often assists in the removal of the superfluous spray reflected back toward the operator."

Prevention

It can be taken as axiomatic that the chief danger in painting so far as lead poisoning is concerned is from inhalation of lead dust. Prevention must accordingly lie along one of two lines; either, (1) substitution of some other pigment for lead, or (2) concentration on the problem of (a) dust prevention, (b) dust removal.

(1) Substitution of some other pigment for lead*

The possibility of substituting zinc for lead has been widely considered on its commercial and practical side. The question is still in its experimental stage and no authoritative conclusion has been reached. The policies of other countries in the matter are briefly as follows:

Germany, Belgium, and Switzerland are endeavouring to safeguard the painting trade by strict regulations, chiefly the prohibition of dry rubbing down and compulsory provision of washing facilities. Switzerland tried total prohibition of use of lead paints in 1904, but found it impracticable.

Austria has since 1909 forbidden the use of white lead for indoor work, and following upon this has recently put 35 varieties of leadless paint on the market. Most of these contain iron but some are compounded with zinc, aluminium or manganese.

France has since 1915 prohibited the use of white lead in all painting operations on buildings, whether for interior or exterior work.

In the *Netherlands* a Commission was appointed to investigate the question of substitution of zinc-white paint for lead-white paint and reported in 1909 most emphatically for substitution.

In *England* the British Departmental Committee on the Danger in the Use of Lead in the Painting of Buildings heard many witnesses on the prac-

* For full discussion of the possibility of substituting zinc white paint for lead white, see Report of the Br. Departmental Committee on the Danger in the Use of Lead in the Painting of Buildings, 1914, reprinted by U.S. Bur. of Lab. Statistics, Bull. 188, 1916; and Report of the Netherlands White Lead Commission, published in Appendix III of the Br. Report referred to above, and obtainable from H.M. Stationery Office, Imperial House, Kingsway, London, England.

ticability of prohibiting the use of lead for painting. It was generally conceded that for interior work lead paint could be dispensed with and some master painters thought zinc paint could also be substituted for exterior work. On the whole, however, the Committee decided to compromise between the alternatives of (a) total prohibition and (b) enforcement of precautions within the trade by recommending (c) restrictions of the amount of lead in paint. Their recommendations were as follows:¹

(1) "A law should be introduced prohibiting the importation, sale, or use of any paint material which contains more than 5% of its dry weight of a soluble lead compound when determined in the following manner:

If the paint or wash be mixed with water, turpentine, oil, varnish, size, or other adhesive or waterproofing substance, it shall first of all be freed as far as possible from such vehicle or adhesive or waterproofing substance by drying or by treatment with ether, petroleum, spirit alcohol, water or other neutral solvent or solvents. If the residual substance so obtained should contain insoluble varnish matter, size, or other adhesive material which cannot be removed except by the action of reagents which affect the other constituents of the paint or wash, then the proportion of such varnish, matter, size, or other adhesive material shall be ascertained by suitable means, and a deduction be made for the same from the weight of residual matter taken for the determination of the soluble lead, so that the proportion of soluble lead found to be present shall be calculated as a percentage of the dry matter free from varnish matter, size, etc. For the determination of soluble lead, a weighed quantity of the dried or dry material, freed as far as possible from oil, or other vehicle, or adhesive substance above described, is to be continually shaken for one hour, at the common temperature, with 1,000 times its weight of an aqueous solution of hydrochloric acid containing 0.25 per cent. of actual or real hydrochloric acid. This solution is thereafter to be allowed to stand for one hour and to be passed through a filter. The lead salt contained in an aliquot portion of the clear filtrate is then to be precipitated as lead sulphide and weighed as lead sulphate."

Exemptions.

Certain classes of colours used by artists and also the industries where the use of lead paints containing more than the specified amount of lead cannot yet be dispensed with, subject to enforcement of precautionary measures such as abolition of dry-rubbing down, provision for overalls, mess rooms, cloak rooms, lavatories, medical examination, etc.

Grace allowed.

"Three years from the publishing of this report."

(2) Dust prevention and dust removal

Failing prohibition of the use of lead in painting, it is along the following lines, somewhat overshadowed hitherto by the overdue emphasis of personal cleanliness, that prevention should be mainly directed.

The chief source of dust—dry sandpapering and "dry rubbing down."

As regards the chief source of dust, namely, dry sandpapering and "dry rubbing down," it has been seen that Germany, Belgium and Switzerland have prohibited both. The English Committee accepted the evidence of the majority of witnesses that "dry rubbing down" was a necessary process as applied to early coats of new paint before the application of the final coat.

¹ Report of British Departmental Committee on the Danger in the Use of Lead in the Painting of Buildings, 1914, Reprinted by U.S. Bur. Lab. Stats., 1916, Bull. No. 188, p. 152.

The following are suggestions from various sources as to non-dust-producing methods of sandpapering and rubbing down.

Moistening of the sandpaper by turpentine or some similar fluid, other than water.

This method was advocated by some of the witnesses heard by the British Departmental Committee but was considered impracticable by the majority.

Moistening of the sandpaper with a cheap mineral or hydrocarbon oil.

Dr. Hamilton advocates this in the following terms: "It is entirely possible to do away with the dust of the rubbing process by keeping the sandpaper moistened with one of the cheap mineral or hydrocarbon oils, choosing one, of course, that has a low flash point and that is neither too slow nor too rapid a drier. The sandpaper lasts as well with as without the oil and the result upon the paint is fully as good. It is a method with which many German painters are familiar and if it could be generally introduced in this country a great step forward would have been taken in improving the conditions in house painting and carriage and railway coach painting and ship painting."¹

Hayhurst also considers that dust from sandpapering can be entirely checked by the use of mineral wool.

Use of wet pumice stone with wood block or felt.

Hayhurst further thinks that in many industries the use of wet rotten stone or pumice-stone powder applied with a basswood block or piece of felt will permit of "rubbing down" without the creation of dust.²

Subsidiary preventive measures.

Subsidiary, but only subsidiary, preventive measures are the same for the painting industry as the general measures advocated for all lead trades and dealt with in this book in the chapter entitled "Prevention." Briefly, they are provisions of washing facilities, good food, with special emphasis on an ample breakfast, and free drinking of milk, compulsory wearing of working clothes and frequent cleansing of these, use of respirators and other individual devices to prevent dust inhalation, frequent medical inspection, etc.

Many authorities also refer to the usefulness of requiring that the lead content of paint should be clearly marked on all cans in order that painters may know the danger to which they are exposed. Such action would at the same time be a simple means of preventing ill effects of the dryers (turpentine, benzene, etc.) being ascribed to lead.

Lead poisoning among painters complicated by effects of the liquid vehicles

The subject of the ill effects of the liquid vehicles of paint, especially of turpentine, calls for more investigation than it has yet had. The question falls outside the range of the present book, but reference must be made in passing to the experiments of Sir Kenneth Goadby³ as to the physiological effects of turpentine on animals. He drew attention to the effect on the kidney, producing interstitial hæmorrhage and generalized nephritis, and suggested that turpentine vapour increases the susceptibility of painters to kidney disease and accelerates the action of lead upon those organs.

¹ "Hygiene of the Painters' Trade," Dr. Alice Hamilton, U.S. Bur. of Lab. Statistics, 1913, Bull. No. 120, p. 35.

² Hayhurst, "Industrial Health Hazards and Occupational Diseases in Ohio," 1915, p. 384.

³ Vol. III, Appendices to the Report of the British Departmental Committee on Danger in Use of Paints Containing Lead in the Painting of Buildings and in the Painting, Enamelling and Varnishing of Coaches and Carriages, p. 27.

VI. Potteries, tile works and porcelain enameled sanitary ware

This is a notable instance of an industry where lead poisoning can be greatly decreased by hygienic precautions. The decline of poisoning in English potteries following upon preventive legislation has been very marked: in 1900 there were 200 cases, with 8 deaths; in 1912, 80 cases, with 14 deaths; and in 1918, 11 cases, with 1 death.

In the United States, conditions in 1912 were, according to an investigation made by Dr. Hamilton, very bad. She found 60 cases of poisoning over a period of two years among 796 male employees in whiteware potteries, and the records of the East Liverpool dippers' union showed that one dipper out of every six or seven suffered from poisoning. Comparing all the American potteries visited by Dr. Hamilton in 1911 with the figures for all British potteries in 1910, it appears from the following table that with less than one fourth the workers involved, American potteries suffered almost twice as many cases of lead poisoning as did the British potteries.

All American pottery workers as compared with all British pottery workers:

FREQUENCY OF LEAD POISONING CASES IN EACH SEX, IN ALL POTTERIES, GREAT BRITAIN, 1910, AND IN POTTERIES VISITED, UNITED STATES, 1911.¹

Sex	All Potteries, Great Britain			Potteries visited, United States, 1911		
	Employees in 1907	Cases of lead poisoning, 1910	Ratio of cases of lead poisoning to number of employees	Employees	Cases of lead poisoning	Ratio of cases of lead poisoning to number of employees
Males.....	4,504	40	1 to 113	1,100	87	1 to 12 or 13
Females.....	2,361	37	1 to 64	393	57	1 to 7
Total.....	6,865	77	1 to 89	1,493	144	1 to 10 or 11

Incidence of lead poisoning in American potteries in 1921

In an investigation made in New Jersey, Ohio, Pennsylvania and West Virginia, by the U.S.P.H.S., in 1921,² the incidence of lead poisoning, as judged by physical examinations among pottery employees was found to be as follows:

Out of a total of 17,279 employees, 1902, or 11 per cent., were classed as exposed to the lead hazard, and 1809 were examined for symptoms of poisoning.

Among the 1809 employees examined there were found:

139 cases of positive lead poisoning.

106 cases of presumptive lead poisoning.

168 cases of suggestive lead poisoning.

413 total.

1,396 cases in which there was no evidence of lead poisoning.

The rates of plumbism were accordingly as follows:

Including only positive cases, 7.7 per cent., or 77 per thousand of those examined.

¹ Alice Hamilton, Lead Poisoning in Potteries, Tile Works and Porcelain Enameled Sanitary Ware Factories, 1912, U.S. Bur. of Lab. Bull. No. 104, p. 53.

² B. J. Newman, W. J. McConnell, O. M. Spencer and F. M. Phillips, Lead Poisoning in the Pottery Trades, U.S.P.H.S., 1921, Bull. No. 116, p. 90.

Including positive and presumptive cases, 13.5 per cent., or 135 per thousand of those examined.

Including positive, presumptive and suggestive cases, 22.8 per cent., or 228 per thousand.

Lead glazes the source of danger

It is in the lead content of the glazes used in all branches of the pottery industry that danger of lead poisoning arises. In England the glazes have to be "fritted" so as to render the lead less soluble, and a standard of insolubility has been fixed. Moreover, the restrictions in factories using lead glaze in any form are such that an incentive is given for them to adopt leadless glaze as a means of freeing themselves from arduous regulations.

Dr. Hamilton found glazes containing up to 60 per cent. of lead* and pointed out that although American glazes are "fritted," this is done *before* and not after the lead is added, so that the solubility of the glaze remains unaffected.

Another great difference noted by the same author in English and American methods is that most English factories use a leadless glaze for porcelain enameled bathtubs, sinks and basins. American factories generally use an enamel containing from 5 to over 25 per cent. lead.

General principles of prevention which have been adopted in England:

As Dr. Hamilton points out, the economic conditions of American factories are probably better than those in England, and accordingly the lower incidence of poisoning in the latter country must be attributed to the better hygienic conditions. The general principles of prevention adopted in England are as follows:

1. Insolubility standard for lead glazes.

Lead glazes have to be "fritted"—that is to say, the white lead is fired with silica or boric acid so as to render it more insoluble. The standard of insolubility adopted is that glazes shall not yield more than 5 per cent. of lead, calculated as lead monoxide, when acted upon by a weak solution of hydrochloric acid under certain specific conditions.

2. Prohibition of women and children altogether in certain processes and, except with certificate of *permission to work*, in other processes.
3. Periodic monthly examinations of workers in certain processes.
4. Insistence upon provision of efficient exhaust draughts for certain processes.
5. Detailed regulations as to cleanliness of work rooms and wet methods of cleaning.

Detailed description of pottery processes in U.S.A.†

There are four industries included under the title of potteries, tile works and porcelain enameled sanitary ware:

1. The making of so-called white ware, which means sanitary earthenware and table and toilet ware.
2. The making of earthenware bowls, pots, etc., usually known as "art and utility ware."
3. The making of lead-glazed wall, floor and roof tiles.
4. The making of porcelain enameled iron sanitary ware.

* The U.S.P.H.S. investigation in 1921 showed that glazes contained up to 45.70% of soluble lead.

† Based on Lead Poisoning in Potteries, Tile Works and Porcelain Enameled Sanitary Ware Factories, by Alice Hamilton, 1912.

The common practice in these industries is the employment of lead glaze; otherwise the processes vary in the four industries.

Processes of the first three industries involving danger in lead poisoning:

- (a) Mixing the glaze.
- (b) Dipping the ware in the glaze or other means of glaze application.
- (c) Handling the ware while it is still wet.
- (d) Removing excess glaze from dry ware.
- (e) Decorating the ware with lead colours.
- (f) Cleaning and sweeping of rooms, tables, etc.

Processes of the fourth industry involving danger of lead poisoning:

- (a) Mixing and grinding the ingredients of enamel.
- (b) Applying the enamel.

Composition of glazes

No table or toilet ware is made in U.S.A. with leadless glaze.

Sanitary earthenware is made partly with lead glaze, partly with leadless.

Cheap earthenware (known as yellow ware and Rockingham), art pottery and coloured tiles have glaze which is rich in lead.

White tiles are often glazed with a glaze containing only small quantities of lead.

Amount of lead in glazes

Amounts vary from under 5 per cent. in sanitary ware to between 50 and 60 per cent. in yellow ware and tile works.

Lead-fritted glazes not used in U.S.A.

American glazes are fritted, but *before* instead of after the lead is added.

1. Description of processes in white ware (table, toilet and sanitary earthenware).

Mixing

Borates and silicates are mixed and then melted into a fluid mass, which is run into water, where it scatters and hardens quickly in feathery masses. This so-called frit is then ground to a powder and white lead and other ingredients added. It is again ground in water-mills, then fritted through silk sieves and, suspended in water, is now ready for use by the dippers.

Hazards.

The dangers come from shovelling, weighing and carrying the lead for the glaze and from grinding and sifting the glaze. In some cases the mixers do not know what materials they are handling.

With ordinary care, dangers should not be great and glaze should be mixed in large quantities at a time.

Dipping

This is highly skilled work, consisting in rapidly mixing the biscuit ware in liquid glaze, turning it, and bringing it out in such a way that the glaze is evenly distributed. The glazed ware is placed on a board or tray to dry and later is carried to the glost kiln for firing.

Hazards.

The dipper's arms are covered with glaze and his clothes and the floor splashed. When this dries it is constantly stirred up in dust by being walked on.

Precautions.

Floors should be of cement, and should be kept damp.

Food should not be eaten in workrooms.

Dippers should wear overalls and should be careful to wash before eating, etc.

Dippers' helpers

These sponge or otherwise clean the ware to get rid of the glaze at the foot, stack the ware on trays and, in some cases, carry it to the glost kiln for firing.

Hazards.

Glaze dust from the boards and trays, etc., when the ware has dried and from cleaning of the trays, etc.

Work of glost kiln men

In some cases these men simply place the glazed ware in saggars, but in others they rub off the excess glaze first and this is very dirty work.

Hazards.

Lead dust, if the ware is finished by the glost kiln men when the glaze has had time to dry.

Precautions.

Ware should be finished by the dippers' helpers while it is wet and not by the glost kiln men.

Colour work

The preparation of colours, tinting and ground laying are decidedly dangerous work.

Ground laying consists in "dusting dry colours on a prepared surface by means of pads of cotton. The colour sticks to the prepared part of the ware and is wiped off from the edges with clean cotton."

Ground laying is being replaced by tinting. In this, colours are applied in a spray, driven through an atomizer by compressed air. (This process is called in British reports, "colour blowing.") "The ware is held under a hood, at the back of which is an electric fan, fixed in a flue or hole in the wall which communicates with the outside air. If this fan exerts the proper amount of suction, and if the spray is not driven with too much force through the atomizer, and if the hood is deep enough to allow the ware to be held a little distance from the tinter, the dangers have been minimized as far as possible."

Hazards.

When the above devices are ineffective, tinters may get covered with a fine spray of colour. The English experts also recommend short-sighted people being prohibited from this work owing to dangers of breathing lead dust as they bend over their work.

2. Description of processes in art and utility ware, including yellow ware and Rockingham**Yellow ware and Rockingham**

These are made from brown clays and the glaze contains more lead than does the white ware, usually containing from 40 to 50 per cent. of a mixture of white and red lead. One advantage, however, is that no sponging or rubbing of the glaze is done.

Art and utility ware

Glazes run from 10 to 50 per cent. lead. Dippers do finishing as well as dipping, either sponging the ware or scraping off the glaze after it is partly dry, an operation known as fettling. There is a great deal of tinting done.

Hazards

Dangers from glazes rich in lead and from the large amount of tinting.

3. Description of processes—making of lead-glazed wall, floor, art and roof tiles:**Composition of glazes**

These contain large amounts of lead.

Dipping

(a) Hand dipping.

(b) Pouring.

(c) Machine dipping.

(a) In hand dipping, only one side of the tile is glazed, and the hand need not be immersed.

(b) In pouring, a number of tiles are placed on a sloping surface which drains into the dipping tub, and the glaze is poured on them. The disadvantage is that a good deal of glaze runs over the edge of the tile and has to be scraped off later.

(c) Machine dipping is the safest way, the only hand work required being to place the tiles on the travelling belt of the dipping machine and later to take them off. No scraping is required.

Finishing

Either (a) the edges of the tiles are scraped with a knife, a process known as fettling; or (b) they are brushed.

The work is very dusty if the tiles are allowed to dry and the scrapings permitted to fall on the floor. The English experts advise all scraping of glazed tiles to be done over troughs of water.

Coloured tile glazing

Usually done by hand. Some methods employed are very dangerous, involving sifting of dry-coloured glazes on the tiles, or dabbling on of coloured glazes with balls of cotton.

4. The making of porcelain, enameled iron, sanitary ware, bath tubs, sinks, basins, etc.*

"The cast-iron bathtubs, sinks and basins which have been roughened by sand-blasting are first given a coat called the 'slush' or 'ground' coat to fill the pores of the iron, to make the enamel adhere to it, and to bring together the expansion coefficient of iron and enamel. This slush contains small quantities only of lead."

Composition of the enamel

"The enamel used on sanitary ware is a lead glaze consisting of silicates, borates, fluorides, alkalies, usually both soda and potash, introduced in part as feldspar, carbonates or nitrates; alkaline earths, calcium, magnesium and barium oxide; and the oxides of tin, zinc and lead. These are fused to a liquid and run out from the oven into cold water, which causes it to harden into feathery masses known as the 'frit.' After drying, the frit is ground and sifted and then is ready for use." The lead content varies greatly. One writer mentions 16 per

* The great majority of English and German factories use only leadless glaze for this ware.

cent. as the proportion of lead in use in three American factories, but states that higher proportions would be used for certain kinds of ware. The fritting process in use in American sanitary ware establishments has been shown not to render the lead insoluble.

Mixing of the enamel

In mixing, workers have to handle oxides of lead. Materials are stored in bins or barrels and handled with shovels. It can be very dusty work, but a properly protected chute from the storage bins to the mixing room, a hood with a good draft over the bins in the mixing room, and a closed mixer can lessen the dangers.

Grinding the dry frit is apt to be very dusty work.

Enameling

The bathtubs, sinks, basins, etc., which are to be covered with enamel come from the sand-blasting department to the slushers and after it has been slushed is handed over to the enamelers, who put it in the furnace until it is red hot. It is then brought out and placed on a turntable in front of the furnace door. The helper turns the ware at different angles, while the ensembler shakes the powdered glaze over it, using a dredge. Large dredges are worked by compressed air or electricity. Several coats of enamel are required and for the last the worker must come as near the ware as the heat will allow.

Hazards.

Enameling is exceedingly dusty work, walls, ceilings and windows of work rooms getting white with dust. Enamellers work on the piece-work system and in six or eight hour shifts, with no formal pause for lunch. Food is eaten in the interval while the ware is heating, in the dusty atmosphere.

Prevention of lead poisoning in potteries

Apart from general methods of prevention on the lines of plant cleanliness, dust prevention, medical supervision, etc., there are three special means of improvement recommended by the U.S.P.H.S. as the result of their survey.¹

These are,

- (a) Reduction in the amount of lead used in the glaze.
- (b) Continuous kilns.
- (c) Mechanical means of dipping.

(a) Reduction in the amount of lead used in the glaze

Apart from the vexed question of the practicability of leadless glazes, most investigators agree that the best method of eliminating lead poisoning in the pottery industry is the practice of fritting the lead in the glazes. The feasibility of the method was submitted to R. L. Stull, at the Ceramic Laboratory, U.S. Bureau of Mines, who reported as follows:

Report of specialist on feasibility of fritting lead glaze²

"In order to reduce the hazards of lead poisoning in potteries using glazes of the whiteware type, it is advantageous to frit all of the lead. If the frit is properly constituted it is practically insoluble to most dilute chemical reagents, and thereby eliminates the possibility of lead poisoning to workmen who come in contact with the glaze. However, the weighing of the frit, its mixing and

¹ B. J. Newman, W. J. McConnell, O. M. Spencer, F. M. Phillips, Lead Poisoning in the Pottery Trades, U.S.P.H.S., May, 1921, P.H. Bull. No. 116, pp. 179-185.

² B. J. Newman, W. J. McConnell, O. M. Spencer and F. M. Phillips, Lead Poisoning in the Pottery Trades, U.S.P.H.S., 1921, Bull. No. 116, pp. 180-184.

fritting operations, offer opportunities for lead poisoning; but these operations are usually confined to two or three workmen, so that the number of employees coming in contact with soluble lead is reduced to a minimum. Much can be done in the way of education. If the workmen who prepare the frit understand the causes and effects of lead poisoning and are compelled to take proper precautions, no contraction of lead poisoning need occur.

"There are three ways by which the frit may be changed so as to include all the lead. First, the lead may molecularly replace part or all of the whiting in the original frit, or, second, it may replace parts of the whiting, zinc oxide, and barium carbonate, if the two latter are present. This can generally be done without changing the general frit formula to its oxygen ratio. Third, in "high lead" glazes maturing at low temperatures, the amount of raw lead in the glaze may be so great that there are not sufficient replacement RO's (whiting, zinc oxide, etc.) in the frit to take care of the lead. In such a case, it becomes necessary to construct an entirely new frit, which should contain sufficient alumina and silica introduced in the form of feldspar, clay and flint to form a well-balanced frit, low enough in solubility to be harmless. Glazes Nos. 1 and 1A represent a case in which all the lead is introduced into the frit by molecularly replacing part of the whiting.

Batch composition, glaze No. 1.

	<i>Per cent.</i>
Frit.....	42.35
Feldspar.....	8.01
Whiting.....	5.72
White lead.....	19.89
China clay.....	6.58
Flint.....	17.45

Formula, glaze No. 1.

0.11 K ₂ O	} 0.25 Al ₂ O ₃	} 2.8 SiO ₂
.11 Na ₂ O		
.53 CaO		
.25 PbO		
<hr/>		
1.00 RO		

Batch composition, frit for No. 1.

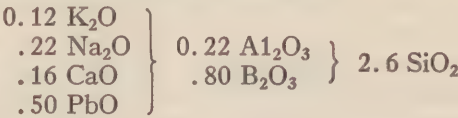
	<i>Per cent.</i>
Feldspar.....	17.20
China clay.....	6.65
Borax.....	21.65
Whiting.....	17.01
Boracic acid.....	11.51
Flint.....	25.98

Formula, frit for No. 1.

0.12 K ₂ O	} 0.22 Al ₂ O ₃ } 2.6 SiO ₂	}
.22 Na ₂ O		
.66 CaO		
<hr/>		
1.00 RO	Combining weight	

Combining weight = 296.3.

“Since it requires 0.5 molar equivalents of frit for the glaze, the 0.25 PbO $\div 0.5 = \text{PbO}$ may be substitutes for 0.5 CaO in the original frit formula. The formula for the new frit for 1A then becomes:



1.00 RO.

Combining weight=379.3.

and the batch composition for frit for 1A:

	<i>Per cent.</i>
Feldspar.....	14.29
Borax.....	18.00
Whiting.....	3.43
White lead.....	27.62
China clay.....	5.52
Boracic acid.....	9.56
Flint.....	21.58

“The introduction of 0.5 molar equivalent of the new frit into the glaze formula, together with the proper amounts of feldspar, whiting, china clay, and flint, gives a glaze of the same composition when fired as glaze No. 1.

“Following is the batch composition of the new glaze in which all the lead is fritted:

Batch composition, glaze 1A:

	<i>Per cent.</i>
New frit.....	54.67
Feldspar.....	8.01
Whiting.....	12.98
China clay.....	6.70
Flint.....	17.64

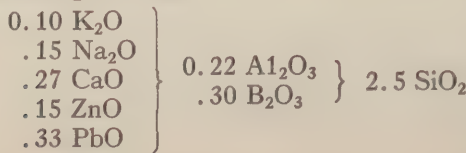
“Glaze No. 2 represents a condition where the lead is substituted for part of the whiting and all the zinc oxide.

“Following are the batch compositions and formulæ of the glaze and frit:

Batch composition, glaze No. 2.

	<i>Per cent.</i>
Frit.....	54.37
Feldspar.....	6.76
Whiting.....	3.65
White lead.....	18.83
China clay.....	4.71
Flint.....	11.68

Formula, glaze No. 2.

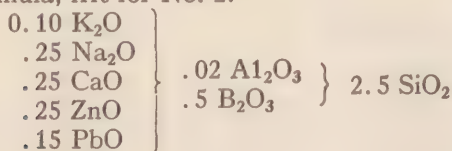


1.00 RO.

Batch composition, frit for No. 2.

	<i>Per cent.</i>
Feldspar.....	15.32
Borax.....	26.32
Whiting.....	6.89
White lead.....	10.67
Zinc oxide.....	5.58
China clay.....	7.11
Flint.....	28.11

Formula, frit for No. 2.



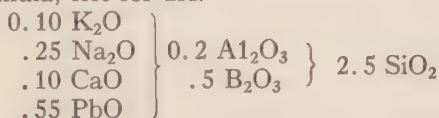
1.00 RO

Combining weight=298.

"Since the glaze requires 0.6 molar equivalent to the frit and since the frit formula contains 0.15 PbO, 0.15 PbO x 0.6, or 0.09 PbO, is brought into the glaze by the frit. The 0.33 PbO in the glaze formula less 0.09 PbO introduced by the frit leaves 0.24 PbO which is introduced into the glaze in the form of white lead and which is to be incorporated in the frit in order that all the lead shall be fritted.

"The 0.24 PbO ÷ 0.6 gives 0.4 PbO to go into the frit formula and replace 0.4 equivalent of the other members in the RO. This may be done by replacing 0.25 ZnO. 0.15 CaO=0.4 RO, which gives the following as the formula and batch composition of the new frit:

Formula, frit for 2A.



1.00 RO

Combining weight=358.

Batch composition, frit 2A.

	<i>Per cent.</i>
Feldspar.....	12.91
Borax.....	22.17
Whiting.....	2.32
White lead.....	32.93
China clay.....	5.99
Flint.....	23.68

"Following is the batch composition of the new glaze, in which 0.6 equivalents of the new frit is used. The formula of the glaze is the same as No. 2.

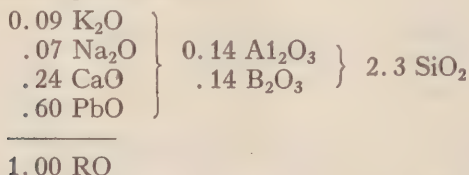
Batch composition of glaze 2A.

	<i>Per cent.</i>
Frit 2A.....	66.28
Feldspar.....	6.86
Whiting.....	6.48
Zinc oxide.....	3.75
China clay.....	4.78
Flint.....	11.85

"No. 3 may be called a "high lead" glaze in which part of the lead is fritted and part is added to the glaze batch as white lead.

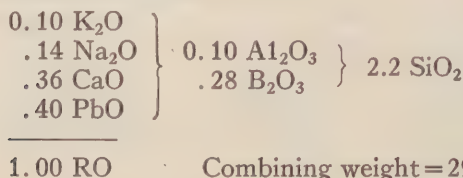
Batch composition, No. 3.	Per cent.
Frit.....	42.60
Feldspar.....	6.52
Whiting.....	1.76
White lead.....	30.23
China clay.....	3.78
Flint.....	15.11

Formula, glaze No. 3.



Batch composition, frit for No. 3.	Per cent.
Feldspar.....	16.15
Borax.....	15.53
Whiting.....	10.46
White lead.....	29.98
Flint.....	27.88

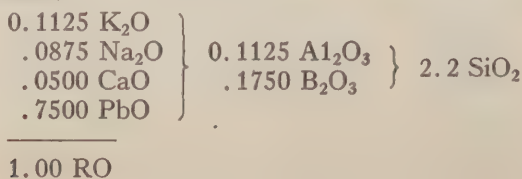
Formula, frit for No. 3.



"In the glaze, 0.5 equivalent of the frit is introduced, which accounts for 0.2 PbO and leaves 0.4 PbO to be added as white lead. The $0.4 \text{ PbO} \div 0.5 = 0.8 \text{ PbO}$. This added to the 0.4 PbO already in the frit formula gives 1.2 PbO. Since the formula is based upon unity RO, all the PbO cannot be taken care of simply by replacement of other members in the RO. It therefore becomes necessary to construct a new frit. In order to frit such a large quantity of lead and produce a frit relatively low in solubility, it is necessary to frit a large portion of the glaze ingredients.

"The following is an illustration showing how the problem of fritting all the lead in glaze No. 3 was solved under practical working conditions:

Formula, frit for No. 3A.



Batch composition, frit for No. 3A.

	<i>Per cent.</i>
Feldspar.....	16.21
Borax.....	8.66
Whiting.....	1.30
White lead.....	50.13
Flint.....	23.70

Combining weight = 341.

Batch composition, glaze No. 3A.

	<i>Per cent.</i>
Frit 3A.....	82.14
Whiting.....	6.02
China clay.....	3.89
Flint.....	7.95

Advantages of fritted glaze

"Besides reducing the hazards of lead poisoning, the advantages of fritting the lead are that it reduces the temperature of the fritting and gives a frit that grinds more readily to a fine condition. In case of No. 3 glaze, where it becomes necessary to frit a larger proportion of the materials, it tends to lower the maturing temperature of the glaze.

"All substances are volatile at some temperature and pressure. During fritting, the lead, borax, and boracic acid lose most by volatilization, especially during the fusion and gas-evolution stages. However, it is not evident that the loss of lead in fritting is any greater than that which occurs in the glaze during the glost fire, when the lead is added to the glaze in the raw or unfritted form.

"During the fusion of the frit, the lead oxide, as well as the borax and boric acid, enters into solution and becomes more or less combined chemically with other components, and in that condition the rate of volatility is much reduced."

Conclusions on fritting lead glazes.

(i) If properly done it is practically insoluble to almost all dilute chemical reagents, and the possibility of lead poisoning to workers who come in contact with the glaze is eliminated.

(ii) By the use of frit the lead hazard is limited to the makers of the frit.

(iii) "Fritted glaze can be used as such for working glaze or in various combinations, thereby lessening the total amount of soluble lead present in a glaze compound, and hence decreasing the possibility of lead poisoning."

(b) Continuous kilns

The U.S.P.H.S. investigators¹ reported that these were beginning to replace the ordinary intermittent kiln. They thought the tunnel kiln the best type, and point out that by doing away with the necessity of saggers it eliminates the lead hazard in sagger washing and also reduces other incidental dangers.

(c) Automatic ware glazing

This is used for glazing tiles, and is being experimented with for other ware.

(d) The English mangle

This is also cited by the authors mentioned above as a means of reducing the lead hazard. "The dipped ware from the tub is placed directly upon the shelf of the mangle and is carried up, dried and conveyed on an endless wheel to a helper, whose duty it is to remove the superfluous glaze on a grating equipped with a suction craft from a blower, which carries away the dry glaze dust."

¹ B. J. Newman, W. J. McConnell, O. M. Spencer, F. M. Phillips, Lead Poisoning in the Pottery Trades, U.S. P.H.S., May, 1921, P.H. Bull. No. 116, p. 184.

VII. The Printing Trades*

The morbidity and mortality of printers and the incidence of tuberculosis are abnormally high, both in Europe and the United States. There is, however, considerable difference of opinion regarding the part played by lead. Most Austrian and Dutch and Italian authorities, and some of the German, hold that it is responsible for much disease among printers, but from the number of cases notified in England, lead poisoning does not seem to be very prevalent among English printers. Statistics for the United States are very scarce, but in an investigation of 200 printers made by Dr. Hamilton and Charles H. Verrill in 1917, 18, or 9 per cent. were classed as indubitable cases of lead poisoning.

Some authorities, including Professor Hahn, of Munich, consider that the pre-disposition to pulmonary tuberculosis on the part of printers is the result of chronic lead poisoning. Oliver, Legge and Goadby, however, doubt this and think the high tuberculosis rate among printers is more probably connected with the over-heated and ill-ventilated workrooms.

There is difficulty in judging the actual effects of printing on the health of those concerned, since most of the mortality and morbidity figures available are continental, and continental authorities seem agreed that printing attracts the weaker members of the community. There is also some confirmation of this view from American experience, the statistics of the Prudential Insurance Company showing slightly lower figures for stature and weight among printers than among occupied males in general.

Composition of type metal

According to Southward's *Modern Printing* (London, 1900), English type metal contains 50 to 69 per cent. lead, 18.8 to 25 per cent. antimony, 9.1 to 25 per cent. tin, and sometimes 1.5 per cent. copper. The American formula is given as 100 parts lead, 35 parts antimony, 15 parts tin, 4 parts copper.

Form of lead poisoning among printers

Dr. Hamilton says that lead poisoning rarely occurs among printers in an acute form, but is of slow and chronic type and not easily recognizable.

Prevalence of lead poisoning

The rate of poisoning varies according to whether or not figures for type foundrymen are included in the statistics. Where they are excluded, the rate of poisoning (clearly recognized as such) is not high. Hahn says that 60 to 90 per cent. of all cases of lead poisoning in the printing trades are among foundrymen (including stereotypers), and compositors.

The statistics available require qualification always from the fact that owing to the chronic type of the poisoning in this industry, many cases are certainly missed. The following figures from a printers' union in Vienna cover only "clear" cases of poisoning. Over a period of six years they had an annual average of 155 cases per 7,000 members, the rate being 1 in 9 among women foundry helpers; 1 in 15 among male type foundrymen; 1 in 35 among compositors; 1 in 40 among pressmen and mechanics; 1 in 68 among male helpers; 1 in 265 among women not in the foundry.¹

* Abstracted almost entirely from *Hygiene of the Printing Trades* by Alice Hamilton and Charles Verrill, 1917.

1 Alice Hamilton and Verrill, *Hygiene of the Printing Trades*, U.S. Bur. of Lab. Stats., 1917, Bull. No. 209, p. 84.

The following table shows the percentage of sickness due to lead poisoning among German workmen in general and among German printers:

TABLE 25.—Per cent. of sickness due to lead poisoning among Printers and among members of General Local Sick Funds of Specified Cities, 1907.

(Source: Die Gesundheitsverhältnisse im polygraphischen Gewerbe Deutschlands, pp. 16, 17).

City and class of workers	Per cent. of sickness due to lead poisoning		
	Males	Females	Both sexes
DRESDEN.			
Members of general sick fund.....	0.80	0.02	0.50
Printers.....	5.15	....	2.93
MUNICH.			
Members of general sick fund.....	.42	.06	.29
Printers.....	2.42	.13	1.32
BERLIN.			
Members of general sick fund.....	.14	....	.07
Printers.....	.96	.03	.68
STUTTGART.			
Members of general sick fund.....	.34	.03	.25
Printers.....	2.51	.25	1.14

Sources of lead poisoning danger

1. *Lead dust.*

In the composing room, dust in type cases.

In the linotype room, the scraps of lead from the machines which fall on the floor, and the dust from cleaning machines and plungers.

In stereotyping and electrotyping, the scraps from trimmers, routers and saws, and the dross from kettles.

In cleaning of type-cases, dry sweeping of rooms, dry dusting of type-casting machines.

2. *Lead fumes.*

There is fairly general agreement that there is no risk of poisoning from actual lead fumes, in the strict sense of the word, in the printing industry, since not enough heat is required to produce fumes. The common view now is that the ill effects experienced by linotypists are not caused by lead fumes, but by carbon monoxide from the gas heaters, and, possibly, by lead dust. At the same time Sommerfeld¹ points out that there might be danger from the oxide which forms on the surface of molten lead and is easily pulverized and blown into the air. Experiments made by Dr. Earle B. Phelps, of the Hygienic Laboratory of the Public Health Service, showed that agitation of melting pots, as in stirring, ladling, pumping or skimming, could cause pollution of the air by the disturbance of the oxide film.²

Dr. Hamilton considers that there is sufficient agitation to cause contamination of the air in the following processes:

Stereotyping.

Electrotyping.

Remelting and casting type.

¹ Sommerfeld, in Leymann's Bekämpfung d. Bleigefahr in d. Industrie, Jena, 1908.

² Quoted by Alice Hamilton and Verrill, Hygiene of the Printing Trades, U.S. Bur. of Lab. Stats., 1917, Bull. No. 209, p. 24.

No fumes in linotype casting

In linotype and monotype casting there should be little agitation of the metal, and therefore no contamination of the air.

Preventive measures

The chief preventive measure is to keep the workrooms themselves as clean as possible, to devise means of cleaning machines, etc., without creating dust, and to prevent the accumulation of lead scraps and trimmings. An elementary precaution, but one very frequently ignored, is the separation of dangerous processes from others. Compositors, for example, are too often needlessly exposed to evaporations from melting kettles. Some of the especial preventive measures for the different processes are as follows:

(1) *Receptacles for scraps from linotype machines.*

Lead accumulates principally around the machines, in shavings and dust, and is liable to be ground up by the feet of the workers. In the royal printing establishment at the Hague each machine has a metal pan fitting accurately around its standard and catching all fragments of lead.

(2) *Receptacles for skimmed-off dross from melting pots.*

(3) *Construction of compositors' stands.*

These should either be flush with the wall so that the dust cannot collect under them, or they should be raised high enough from the floor to permit of sweeping under them.

(4) *Cleaning of type cases.*

Lead dust is more apt to collect in type cases than anywhere else in printing shops, and the cleaning of these has long been a source of danger. The only safe way is to use a vacuum cleaner. Dr. Hamilton describes a combined brush and suction pipe seen in use in the royal printing office in Holland, and also used, she thinks, in France. "This consists of a flat brush with stiff bristles, fastened to the pipe of the vacuum cleaner in such a way that the opening of the pipe is in the centre of the brush. The operator presses this brush down on the type in the case and rubs it to and fro, stirring up the dust and brushing off the type, and the suction in the pipe carries the dust away."¹

Legge and Goadby² describe as follows the Clements printers' case dust extractor: "In the Clements apparatus the cases are placed on a shelf, which is made to oscillate; air is forced into the compartments from numerous jets, so as to raise the dust, which is removed by suction and collected. The cases are thus cleaned with great saving of time in the composing room itself and without contamination of the general atmosphere by dust."

(5) *Non-dust-producing methods of cleaning plungers.*

The cleaning of linotype machines, especially the plunger, which is apt to be covered with a fine deposit of lead oxide, is an obvious danger.

The usual method of cleaning the plunger is to take it out and, while it is still hot, brush it off with a wire brush. Such work is often done by machinists' helpers, who may be engaged in cleaning for considerable time on end, and in so doing are exposed to suboxide of lead dust.

1 Alice Hamilton and Verrill, *Hygiene of the Printing Trades*, U.S. Bur. of Lab. Stats., 1917, Bull. No 209, p. 35.

2 Legge and Goadby, *Lead Poisoning and Lead Absorption*, 1912, pp. 255.

Dr. Hamilton cites various devices she has seen used to minimize danger.

One is dipping the plunger rapidly in water before brushing it; this, if done rapidly so that the plunger is not chilled, does not apparently cause the explosion which might be expected to occur were the plunger returned wet to the lead.

Another method is the use of a light machine oil or lard to keep down the dust. Here again some use this successfully and some insist that the oil clogs the oxide and makes it impossible to clean the plunger.

The safest method, Dr. Hamilton considers, is to clean plungers in a closed box worked from the outside. Such mechanical cleaners are obtainable from printers' supply houses and are said to be saving of labour as well as sanitary. Dr. Hamilton has seen the Ewald linotype plunger cleaner in successful use.

(6) *Hoods to carry off evaporations from melting pots.*

Even those authorities who deny the presence of lead fumes advocate the provision of hoods over melting pots. Austrian regulations of 1911 require this, and also, as far as possible, for linotype pots.

Dangers other than lead

Only actual lead hazards have been considered here, but in practice, of course, it would be necessary to consider the general health hazards of the trade and any other poisons involved.

General conditions.

The chief health hazard emphasized by all authorities, as applying especially to printers, is inactive work, involving much standing, in vitiated atmosphere. Germany, Switzerland, Norway and France have legislation requiring the opening of windows during the lunch hour. Professor Hahn¹ shows the close connection between lead poisoning and tuberculosis in the printing industry, both being highest among workers who are most in contact with lead, and both diminishing as the result of improved health conditions.

Poisons other than lead.

1. *Carbon monoxide.*

Carbon monoxide gas may be a source of danger to printers wherever lead pots are heated by gas. This might be the case in the following processes:

- Linotype casting.
- Monotype casting.
- Remelting of old metal.
- Stereotype casting.
- Electrotyping.

Also, as has been stated, lead pots are often placed in the compositors' rooms, thus exposing compositors to carbon monoxide.

Preventive measures:

Exhaust systems to carry off the gas fumes. Dr. Hamilton says: "The one essential feature is an adequate draft in the pipes. If the draft is strong enough, nothing else is of much importance, and if it is not, the system is a failure no matter how elaborate it is. Pipes leading into a chimney do not give a sufficient

¹ Hahn, Die Gesundheitsverhältnisse im polygraphischen Gewerbe Deutschlands. Quoted by Alice Hamilton and Verrill, Hygiene of the Printing Trades, U.S. Bur. of Lab. Stats., 1917, Bull. No. 209, p. 86.

draft to be of any use. A forward draft produced by a fan is the most effective way of removing the hot and impure air from melting pots."¹

Another method seen by Dr. Hamilton in some of the large American printing establishments is to do away with the use of gas altogether, and to use electrically heated linotype pots. The electric heating unit can be introduced into the pot. This method does away with gas fumes and heat and also renders piping unnecessary.

2. *Antimony.*

Type metals contain varying amounts of antimony, which adds to the dangers of the lead, since it promotes vaporization at a lower temperature than required for lead alone.

■ A few writers consider that antimony poisoning is the cause of some of the symptoms among printers usually attributed to lead. Others believe that antimony is the source of little trouble in this trade.

3. *Benzine, kerosene, lye, petroleum, etc.*

These are used as type and roller cleaners and are responsible for various forms of dermatitis occurring in printers.

4. *Anilin.*

This is also used as a roller cleaner and is reported to have caused severe poisoning in a few instances.

VIII. Rubber industry

While the rubber industry is not generally regarded as being by any means one of the chief dangerous trades as regards lead poisoning, it is worth mentioning inasmuch as some American factories have a relatively high proportion of poisoning in relation to the small number of men actually coming into contact with lead. For instance, in one plant, nearly 50 per cent. of the employees who were exposed to lead contracted poisoning. Hayhurst, in his investigation in Ohio, found 22 positive cases among 151 employees engaged in rubber compounding.

Description of the processes where lead poisoning is a hazard*

Workers are exposed to lead in the following processes:

Compounding.

Mixing.

Tire building.

Buffing.

Compounding

This is the mixing of ingredients, usually metallic oxides and salts, to be mixed with the rubber later. The dry powders are scooped out of tins, weighed by hand, placed in open-top tin boxes, and carried to the mixing mills. Sometimes the ingredients are first bolted in shakers to break up lumps, and this, unless the shaker is well inclosed, is exceedingly dusty work.

The danger is from lead dust.

Preventive measures.

Dust exhaust system.

Respirators.

Instruction in general lead poisoning precautions.

Washing facilities, etc.

Medical supervision.

¹ Alice Hamilton and Verrill, *Hygiene of the Printing Trades*, U.S. Bur. of Lab. Stats., Bull. No. 209, p. 41.

* Taken from "Industrial Health Hazards and Occupational Diseases in Ohio," E. R. Hayhurst, 1915, pp. 206-229.

Mixing

In mixing mills, the washed and dried rubber is macerated between steel rolls, while at intervals the workman pours upon the rolls ingredients delivered to him from the compounding room.

The danger is from lead dust.

Preventive measures.

Each milling machine should be provided with efficient means of confining or drawing off the dust and fumes.

Other measures as above.

Tire building

This process consists in the making of casings for automobile or bicycle tires by the applying of layers of rubber fabric upon wheel-shaped moulds; to these are cemented the beads, cover layers, etc. It may be all hand work, the operator stretching the fabric as he revolves the wheel, or much of the work can be done by mechanical application of the fabric to the moulds, called "machine building."

There is some slight danger of lead poisoning from handling the rubberized fabric.

Buffing

Rubber tire casings when partly built are roughened up by revolving them on a wheel and holding a coarse file against them. Other semi-hard rubber objects are also buffed, usually by pressing them against a revolving emery wheel. The object of roughing up the rubber is to give surface for the cement which is later applied in order to put on further coats or covers.

The danger of lead poisoning in this process is in direct proportion to the amount of dust inhaled and ingested. The worker can be little blamed for personal carelessness where dust flies all over him.

Preventive measures

Efficient exhaust system.

IX. Metallic Lead Trades

Industries involved

The industries involved are very many in number. The following, in which lead poisoning has been known to occur in U.S.A. in quite serious form, may be cited:

Lead burning.

Making solder and babbitt.

Soldering.

Making lead pipe, sheet, wire, machine parts, plumbers goods.

Making shot.

Lead tempering of machine parts.

Making and laying electric cables.

Making lead trimmings for coffins.

Making leaden picture frames.

Making and using tin foil.

Making car seals and can seals.

Brass founding.
 Brass and nickel buffing.
 Tinsmithing.
 Plumbers' trades.
 Typographical trades.

Description of some of the trades

(1) Lead burning or soldering¹

These processes are practically the same.

Soldering may be done by hand or by machinery, the latter especially in the case of manufacture of tin cans or the sealing of these in canning factories.

There is danger of lead poisoning from handling fumes and dust.

Preventive measures consist chiefly of hoods, exhausts and blow fans to remove solder and gas fumes, and the exclusion from hand soldering of all who have not passed nose, throat, eye and chest examination.

(2) Manufacture of lead pipe, lead tubing and solder wire²

The processes used for these three products are similar. The work is done almost entirely by machinery and the workers only handle the metallic lead.

The molten lead is run into a receptacle at the bottom of a hydraulic press. An aperture and mould is left at the top, which gives the size of the tube which is to be made. The press is then set in operation and the lead is pressed upward through the aperture forming the tube the desired size.

(3) Manufacture of sheet lead³

The lead is run into considerable sheets, several inches in thickness. These sheets are then run between two revolving rollers until the desired thickness is secured. They are then cut to size by hand and the remnants chopped with an axe and returned to the melting pot.

(4) Lead tempering of machine parts⁴

One method of tempering, that is, hardening of metals and metal surfaces, is to dip the object into hot baths of lead.

Danger is from handling of lead and from hot fumes.

Preventive measures are gloves, and hoods to remove fumes.

(5) Manufacture of lead-foil and tin-foil⁵

The use of tin alone is rare, and most foils comprise from 5 to 80 per cent. of lead.

The pig lead is melted up and cast into slabs about 2½ ft. square and 1 in. thick, which are then rolled between large rollers until they are of the required thinness.

In making bottle tops a heavy thickness of very pliable lead foil is used and is shaped by automatic machines.

A certain chemical compound, the formula for which is secret, is added to the lead and tin mixture in the molten slabs which gives the tin-foil its brilliance.

(6) Tinning⁶

Tinning or tin plating is a process in which a very thin layer of tin, often largely mixed with lead and sometimes zinc, is applied to sheet iron, or black

¹ Taken from "Industrial Health Hazards and Occupational Diseases in Ohio," E. R. Hayhurst, 1915.

² Taken from "A Preliminary Report on Lead Poisoning in the City of New York," by E. E. Pratt, N.Y. State Factory Investigating Commission, 1912, vol. I, pp. 433, 434.

³ Taken from "A Preliminary Report on Lead Poisoning in the City of New York," by E. E. Pratt, N.Y. State Factory Investigating Commission, 1912, vol. I, pp. 433, 434.

⁴ Taken from "Occupational Diseases and Industrial Hazards in Ohio," E. R. Hayhurst, 1915, p. 147.

⁵ Taken from "A Preliminary Report on Lead Poisoning in New York City," by E. E. Pratt, N.Y. State Factory Investigating Commission, 1912, Vol. I, pp. 435, 436.

⁶ Taken from "Occupational Diseases and Industrial Health Hazards in Ohio," E. R. Hayhurst, 1915, p. 156.

plate or castings. The usual method is that "sheets from the 'white pickle' are dipped (by hand or machinery) into a flux of sal-ammoniac, hydrochloric acid, and zinc, then into 70 per cent. lead and then into pure molten tin, from which they emerge under a layer of palm oil or other oil. They are next polished and cleaned by hand, or in rollers with middlings (bran), ground peanut shells, or sawdust and rags. The hand dipping is done by skilled men who use tongs to hold the sheets."

There is danger of lead poisoning from the handling of lead orterne plate, which is very rich in lead, and also from fumes caused by the constant stirring of tin-lead alloy.

Preventive measures

All alloy pots should be well hooded and vented.

APPENDIX A

RESULTS OF VARIOUS EXPERIMENTS BY SIR KENNETH GOADBY ON EFFECT ON ANIMALS OF EXPOSURE TO VAPOURS FROM PAINT.

In connection with the work of the British Departmental Committee on danger in use of paints containing lead in painting of buildings, Sir Kenneth Goadby¹ made various experiments which may be summarized as follows:

SUMMARY

(1) Physiological effect of exposure of animals to

(a) Vapours given off from painted surfaces, and

(b) Emanations from white lead ground up in linseed oil

(a) The animals exposed to vapours from painted surfaces developed a severe illness, but the symptoms were *not* those of lead poisoning, and no evidences of such poisoning were found on making the post-mortem examinations. Chemical examination of the air showed no trace of lead. It was concluded that the symptoms were not produced by the metallic basis of the paint but by the thinners and driers.

(b) The animals exposed to air passed over warm white lead and linseed oil developed no symptoms of lead poisoning, did not lose weight, and showed no sign of lead poisoning in the autopsy. Chemical examination of the air also showed no trace of lead.

(2) Physiological effect of exposure of animals to vapours given off from constituents of paint other than metallic salts

Animals were exposed to:

- (a) Vapours from linseed oil;
- (b) " " solution of lead acetate in turpentine;
- (c) " " turpentine.

(a) No symptoms were produced in the animals.

(b) Slight symptoms were produced in the animals.

(c) Very severe and pronounced symptoms were produced and a cat died of acute encephalopathy. The effect on the kidneys, producing interstitial hæmorrhage and generalized nephritis, is significant, and it is not improbable that turpentine vapour increases the susceptibility of painters to kidney disease and accelerates the action of lead upon those organs.

FULL ACCOUNT OF THE ABOVE EXPERIMENTS

Physiological effect of exposure of animals to vapours given off from painted surfaces

Method of experiment.—The apparatus used in these experiments consisted of a chamber of wood and glass. Back, front and top were fitted with a glass frame, the front pane of glass being cut back to 2 inches from the floor to allow of ventilation. Each chamber had a cubical capacity of about 8.5 cubic feet, or 243 litres. The top of the chamber was separated from the animal by means of wire gauze, and on this gauze were placed boards which were each day freshly painted with the paint under experiment. The animals remained in the chambers during the whole of the time, except when removed daily for cleaning purposes.

¹ Appendices to the Report of the Departmental Committees on Danger in the Use of Paints containing Lead in the Painting of Buildings and in the Use of Lead Compounds in the Painting, Enamelling and Varnishing of Coaches and Carriages, pp. 20-27. H.M. Stationery Office, Imperial House, Kingsway, London, 1920.

TABLE I.

Day	Cat No. 56— White Lead, Oil, Thinnings		Cat No. 58— Lithopone, Oil, Thinnings		Cat No. 57— Zinc White, Oil, Thinnings	
	Weight, Kilogs.	Notes	Weight, Kilogs.	Notes	Weight, Kilogs.	Notes
1	2.400	.....	3.760	.....	1.700	.....
4	2.350	.....	3.600	Animal lethargic.....	1.650	Animal very lethargic.
5	.....	Severe attack lasting 30 minutes	.....	.....	.....	.....
6	.....	Severe attack.....	.....	.....	.....	.....
8	2.150	No further attacks.....	3.350	.....	1.500	.....
11	2.250	" ".....	3.300	.....	1.550	.....
15	2.350	" ".....	3.000	.....	1.750	.....
22	2.550	" ".....	3.250	.....	1.800	.....
28	2.450	" ".....	3.550	Acute attack.....	1.700	.....
Experiments suspended during this interval owing to laboratory alterations and whitewashing.						
36	2.600	No further attacks.....	3.800	.....	1.400	.....
39	.....	" ".....	.....	.....	.....	.....
53	2.500	" ".....	3.750	.....	1.600	.....
62	2.400	" ".....	3.800	.....	1.700	.....
69	2.250	" ".....	3.600	.....	1.750	.....
76	2.150	Coryza developing.....	3.600	Acute coryza.....	1.850	Acute coryza and divergence of pupils.
83	2.200	Coryza more pronounced.....	3.500	Acute coryza.....	1.800	Acute coryza and divergence of pupils.
105	2.250	Animal chloroformed and post- mortem made.	3.800	Animal chloroformed and post- mortem made.	1.150	Animal chloroformed and post- mortem made.

TABLE II.

Similar experiment, but paint used bought in open market; boards painted daily with the paint tested.

Day	Cat No. 201—White Lead		Cat No. 202—Lithopone		Cat No. 203—Zinc White	
	Weight, Kilogs.	Notes	Weight, Kilogs.	Notes	Weight, Kilogs.	Notes
1	2.150	No blood change.....	2.350	Blood examined; no change....	2.900	Blood examined; no change.
7	1.300	No blood change.....	1.750	Basophilia, coryza, paralysis...	2.400	Blood examined; no change. Knee jerks absent. Coryza.
20	1.200	Coryza daily after fresh board put in.	1.250	Basophilia, coryza, paralysis...	1.850	Blood examined; no change. Knee jerks absent. Coryza.
..	.....	Animal chloroformed and post- mortem made.	.....	Animal chloroformed and post- mortem made.	.....	Animal chloroformed and post- mortem made.

These experiments were devised to determine if lead poisoning resulted from breathing the vapours of freshly painted surfaces, it being a commonplace that "paint poisoning" frequently follows from sleeping or living in rooms freshly painted. The three animals exposed to paint fumes certainly developed a somewhat severe illness, but no symptoms of lead poisoning and no evidence of lead poisoning was found on making the post-mortem examinations. The animals had no access to the painted surfaces, but the vapours arising therefrom diffused throughout the chambers; some volatile constituent of the paint was therefore the cause of the illness. The symptoms, vomiting, loss of consciousness with complete anaesthesia, passed off on removal from the chamber, and moreover were less severe as the experiment progressed, owing no doubt to the more volatile constituents of the paint becoming gradually attenuated; the paint samples were kept in the laboratory uncovered and stirred up each morning before painting the boards.

As the experiment progressed the animals became emaciated and had the appearance of lead poisoning, but on careful examination no traces of lead were discoverable; the symptoms were not therefore referable to a volatile compound of lead. The absence of any such volatile lead compound was tested for in another series of experiments. (See Tables III, IV.)

Autopsy.—All animals showed similar appearances. Much wasting of all fat, subcutaneous, mesenteric, nephritic, etc.; pink or cherry-red colour of lungs, flabby and dilated hearts, no staining in large intestine, and few, if any, hæmorrhages, but occasional necrotic patches in the intestinal mucosa. The kidneys were acutely congested.

In these experiments the paint used contained proportionately less "driers" than in the previous series. The paint was kept in the same tins in which it was bought, and stirred up each morning before use. The actual symptoms produced in the animals were less severe than in the previous series, but the same progressive loss of weight took place. There were no evidences of lead poisoning, but there were some evidences of blood destruction and regeneration as No. 202 showed basophile granules in the red blood corpuscles; transient partial paralysis of the hind limbs appeared on the seventh day, but passed off when the animal was removed from the inhalation chamber. The post-mortem findings were similar in the two series of cases (Tables I and II).

Physiological effect of exposure of animals to "emanations."

Method of experiment.—The apparatus in this series of experiments consisted of a chamber of about 250 litres capacity, that is, about 8.5 cubic feet. The chamber was zinc lined, and provided with a glass door. Two openings were made in the cage (a) for introduction of the air containing "emanations," (b) for ventilation, which led directly into the outer air, and this opening was four times the size of the inlet. An apparatus was used, consisting of a glass tube 5 feet 6 inches in length, 2 inches in diameter, surrounded by a coil which could be electrically heated and maintained at a definite temperature by means of a series of resistances introduced into the circuit. The temperature was recorded by a thermo-couple and galvanometer graduated in degrees centigrade. The tube contained the substance to be tested, either *white lead paste or zinc oxide paste*, and in order to ensure the air passing over the warmed paint, and into the cage, the distal end of the tube was connected with a small pressure chamber and pump operated by an electric motor, the rate of the motor being so arranged that the air passed very slowly over the heated surface of the paste into the cage. An entirely new tube of fresh paste was placed in the heating coil once a week. On several occasions 10 litres of air were aspirated from the cage during an experiment, and careful search made for the presence of lead. Although the fluid through which the air was aspirated had a distinct paint smell, no trace of lead was found chemically by the method used in the experiments.

The animal remained in the cage during the whole of the day, was taken out at night and placed in one of the ordinary laboratory cages. The time of exposure to the vapours given off from the heated surfaces of the paint varied, averaging seven hours per diem, the total number of hours exposed being 304.

Post-mortem.—No wasting of muscles or subcutaneous fat. Spleen, liver, pancreas, kidneys, normal; slight decrease of kidney fat. Heart: large, flabby, slight constriction of aortic valves. Lungs: evidence of old pneumonia. Intestines: normal, no hæmorrhages; no dark staining anywhere. Stomach: dilated; mucous membrane normal. No evidence of lead on chemical examination of brain, kidney, or intestines.

This experiment was devised to determine if white lead paste, *i.e.*, white lead ground up in linseed oil, gave off any deleterious vapours which could produce symptoms of lead poisoning in susceptible animals. The apparatus consisted of an inhalation chamber into which was aspirated air which had passed through a tube lined with "lead paste," and electrically heated to 50° C. Any volatile compounds of lead and oil would, therefore, pass directly into the inhalation chamber.

The animal was subjected to breathing the air passed over the heated lead paste six days a week from July to October, averaging seven hours daily; at the conclusion of each day's exposure the animal was transferred to another cage.

During the whole experiment no symptoms of lead poisoning were noticed, and the animal's weight showed no progressive diminution, while the autopsy failed to reveal any signs of lead poisoning. Chemical examination of the vapour passed over the lead paste also failed to show any trace of lead, and the physiological experiment negatives any undetected traces harmful to animals.

Physiological and Toxicological Experiments.

TABLE III.

"Emanations" from White Lead Paste and Linseed Oil, at 50° C., Experiment No. 1, Cat No. 51

Date	Time of Exposure		Weight	T. °C. of Paste	Blood Tests	Notes
1911	Hrs.	Mins.	Kilogs.	°C.		
July 12	6	30	2.650	21	No basophile cells	
13	6	0		53		
14	6	30		60		
17	5	45		58		New valve fitted.
18	7	35		58		10 litres of air aspirated; no lead found.
19	6	0		54		
20	7	30	2.850	48	No basophile cells	Fresh paste in tube.
21	6	34		48		
22	3	0		46		
24	6	30		46		
25	7	10		52		
26	8	0	2.850	45		No signs of plumbism, but animal constipated.
27	7	0		52		
28	6	50	2.650	48		Fresh paste in tube.
29	3	0		50		
31	6	30		52		
Aug. 1	8	0		50		Animal smells strongly of paint; still constipated.
2	8	0		52		
3	8	0		50		
4	7	0	2.450	52		
5	4	0		50		
8	8	0		48		
9	7	0		62		
10	7	0		44	No basophilia	Animal smells of paint; motions normal.
11	7	30	2.700	60		
12	3	30		60		
14	8	0		48		Fresh paste in tube.
15	7	0		48		
16	7	20		46		
17	7	0		40		Fresh paste in tube.
18	6	0		46		
19	2	30		50		
21						Apparatus not run during this week; animal house being whitewashed.
26			2.850			Animal very well; no signs of plumbism; no constipation.
28	8	0		50		
29	8	0		52		
Sept. 2	8	0		50		
9	8	0	2.850	50		Fresh paste in tube.
20	8	0		50		
21	8	0		52		
22	8	0		50		
23	3	0		48		
25	8	50		52		
Sept. 26	8	5		54		Fresh paste in tube.
27	8	20		46		
28	8	10		48		
29	8	15		58		
30	4	15		46	No basophilia.	
Oct. 2	8	0	2.850	52		
9			2.850			Chloroform administered and post - mortem examination made at once.

TABLE IV.
Experiment No. 2, Cat No. 72.

Date	Time of Exposure		Weight	T. °C. of Paste	Blood Tests	Notes
1911	Hrs.	Mins.	Kilogs.	°C.		
Oct. 9	8	0	2.750	50	No basophilia.	.....
10	8	0	.....	48	.....	.....
11	7	40	.....	46	.....	.....
12	8	0	.....	58	.....	.....
13	8	0	.....	46	.....	.....
14	8	40	.....	52	.....	.....
16	8	40	2.500	60	No basophilia.	.....
18	9	0	.....	58	.....	Fresh paste in tube.
19	8	0	.....	56	.....	.....
20	3	0	.....	50	.....	.....
21	7	0	.....	54	.....	.....
23	7	0	.....	58	.....	Fresh paste in tube.
						Animal shows no signs of plumbism.
24	7	30	.....	54	.....	.....
25			.....	.....	.....	Motor broke down; experiment stopped until Nov. 1.
Nov. 1	7	0	.....	50	No basophilia.	New motor; fresh paste in tube.
2	7	0	.....	48	.....	.....
3	3	0	2.650	40	.....	.....
4	7	0	.....	53	.....	.....
6	8	0	.....	60	.....	.....
9	9	0	.....	58	.....	.....
10	8	30	.....	50	.....	Air, 10 litres aspirated off and tested for presence of lead, which was absent.
					
11	3	0	.....	50	.....	.....
12	7	0	.....	50	.....	.....
19	7	30	.....	60	.....	.....
20	8	30	.....	58	.....	.....
21	3	0	.....	50	.....	.....
22	7	0	.....	58	.....	.....
23	7	30	.....	50	.....	.....
24	7	30	.....	50	.....	.....
25	7	0	.....	52	.....	.....
26	2	0	.....	58	No basophilia.	.....
27	5	0	.....	40	.....	.....
28	6	0	.....	53	.....	.....
29	8	0	2.700	50	.....	Chloroform administered and post-mortem made immediately after death.

This was a similar experiment to that detailed in Table III; the apparatus and method were the same. The autopsy showed no signs of lead poisoning, and no signs of plumbism were seen during or after the experiment. These experiments, detailed in Tables I-IV, show that, although certain symptoms are produced in animals breathing the vapour from freshly painted surfaces, the symptoms are not caused by volatile compounds of lead, and that at a temperature of 50° C., no deleterious lead compounds are given off from a mixture of white lead and oil. Chemical analysis of the air from the freshly painted surfaces and also air passed over warm white lead and oil fail uniformly to show the presence of even minute traces of lead, nevertheless, definite symptoms of illness did occur in the animals exposed to the fumes of freshly painted surfaces; from which it follows that the substance producing the symptoms is not the metallic basis of the paint, but is derived from the "thinners" and "driers" with which the paint is mixed for industrial purposes. A series of experiments of physiological nature were, therefore, undertaken to determine the especial component of the paint causing the symptoms; this point is evidently of great importance both industrially in the occupation of painting carried out in closed places as well as the question of "paint sickness" occurring in persons whose houses are in process of repainting.

Control experiment.

As a control to the two series of experiments scheduled in Tables I to IV, the apparatus used in experiments III and IV was made use of, but instead of the electrically heated tube, a

small vessel was substituted containing well dried white lead. The pressure chamber pump was operated in a similar manner by a motor.

TABLE V.

Exposure of animal (cat No. 79) to lead dust in similar chamber to that used for the "emanation" tests, minimal quantity of lead dust blown into cage with apparatus.

Date	Time Exposed		Weight	Blood Tests	Notes
1911	Hrs.	Mins.	Kilogs.		
Nov. 11	6	0	4.050	No basophilia.	.....
8	7	0			.....
9	7	30		Basophilia present	.....
10	4	0			.....
11	4	0			.....
13	3	0			.....
14	4	0			.....
15	3	0			.....
16	7	0	3.100		.....
22	5	0			.....
25	4	0		Basophilia.	Hind limb paralysis apparent.
27	4	0			.....
28	4	0			.....
29	4	0	2.550		Animal destroyed under chloroform.

Post-mortem examination made at once. Complete absence of subcutaneous and mesenteric fat, animal wasted. Liver, spleen, pancreas: engorged with blood, superficial and deep hæmorrhages. Lungs: œdematous emphysema, irregular minute hæmorrhages. Heart: dilated, flabby, but valves competent. Kidneys: no fat, but minute cortical hæmorrhages, blood-stained fluid under capsules. Stomach: full of food, dilated, recent sub-mucous hæmorrhage. Intestines: recent hæmorrhages throughout; large intestine typical lead staining. Chemical analysis showed presence of considerable quantity of lead in fæces and liver.

This experiment was a control to the previous ones set out in Tables III and IV; the minimal quantity of lead dust found to affect the animal in previous experiments was used. Lead poisoning quickly followed the inhalation of this quantity of dust (0.001 gm. per litre). It can be, therefore, concluded that no compounds of lead which produce poisoning in susceptible animals are given off from painted surfaces or from white lead paste even when heated, but that dust containing lead rapidly induces the disease under the same experimental conditions.

Physiological effect of exposure of animals to vapours given off from constituents of paint other than metallic salts.

Three substances were used which are commonly present in lead paints for the purposes of causing them to dry, of mixing them, and of thinning them, namely:

- Linseed oil,
- A solution of lead acetate in turpentine,
- Turpentine,

these three substances forming the common bases or medium of the paints. All these three substances were common to the paints used in the preliminary experiments in which animals were found to suffer from symptoms of coryza, emaciation, and ataxia after exposure to paint fumes from freshly painted surfaces.

Method of experiment.—The apparatus used was similar to that made use of in the dust experiment (Table V), but instead of dust being blown into the cage, the apparatus was modified. A pressure chamber was arranged, connected with the pump, and from this leads were taken off to the three chambers. To ensure proper ventilation three further tubes were inserted in the bottom of each of the three chambers connected with an exhaust ventilation. In this way, thorough and efficient ventilation of the chamber was maintained.

The substances to be tested were placed in small receivers inside the cage, in such a position that they could not be reached by the experimental animals. An air tube from the pressure chamber was led into the receiver, and the receiver filled with the substance; linseed oil, turpentine alone, and turpentine and lead acetate. When the motor was started, air passed through the pressure chamber, and into each of the containers at the same pressure, and a constant stream of bubbles passed through the fluid, and so carried any volatile products from the fluids into the air of the chamber.

It was found necessary to reduce the duration of exposure in these experiments to two hours, as the turpentine animals rapidly showed signs of poisoning.

TABLE VI.
Physiological Experiments with Compounds Used for Paint.

Day	Cat No. 78—Linseed Oil		Cat No. 76—Thinners and Driers		Cat No. 77—Turpentine—Average Content of Air, 10.12 mg. Turpentine per Litre	
	Time Exposed	Notes	Time Exposed	Notes	Time Exposed	Notes
1	Hrs. 1 Mins. 30	Weight, 3,750 kilograms.....	Hrs. 1 Mins. 30	Weight, 3,350 kilograms.....	Hrs. 1 Mins. 30	Weight, 2,700 kilograms. Animal ataxic at 1 hour; external strabismus; salivation.
2	7 0	Blood showed no basophilia; animal went to sleep during the experiment and never showed the slightest symptom of discomfort or evidence of poisoning.	1 0	After 1 hour's exposure, had severe fit with profuse salivation; ataxic, especially on removal from chamber.	1 30	Animal ataxic at 1 hour; external strabismus; salivation.
3	0 20	.....	.. ..	.....	0 20	Animal ataxic at 1 hour; external strabismus; salivation; stranguary.
4	1 30	.....	1 30	Ataxic in 30 minutes.....	1 30	Animal ataxic at 1 hour; external strabismus; salivation.
5	.. ..	.....	.. ..	.....	.. ..	Not exposed.
6	2 0	.....	2 0	.....	2 0	Weight, 2,500 kilograms. Ataxic; salivation; external strabismus.
7	2 0	.....	2 0	Ataxic and salivation on removal.	2 0	Ataxic; salivation; external strabismus.
8	2 0	.....	2 0	.....	2 0	Ataxic; salivation; external strabismus.
9	2 0	.....	2 0	Ataxic and divergence of pupils.	2 0	Ataxic 1 hour; 2 hours unconscious; recovered slowly in 1 hour.
10	2 0	.....	2 0	.....	2 0	Ataxic; external strabismus; salivation.
11	2 0	.....	2 0	.....	2 0	Ataxic; external strabismus; salivation.
12	.. ..	Not exposed.....	.. ..	Not exposed.....	.. ..	Not exposed.
13	2 0	.....	2 0	.....	2 0	Severe ataxia, followed by fit; external strabismus.

TABLE VI.—Continued.

Day	Cat No. 78—Linseed Oil		Cat No. 76—Thinners and Driers		Cat No. 77—Turpentine—Average Content of Air, 10.12 mg. Turpentine per Litre	
	Time exposed	Notes	Time exposed	Notes	Time exposed	Notes
	Hrs.	Mins.	Hrs.	Mins.	Hrs.	Mins.
14	2	0	2	0	2	0
15	2	0	2	0	2	0
16	..	Not exposed.....	..	..	..	..
17	2	0	2	0	..	..
18	2	0	2	0	..	..
19	..	Not exposed.....	..	..	..	..
20	2	0	2	0	..	..
21	2	0	2	0	..	..
22	2	0	2	0	2	0
23	2	0	..	..	..	..
24	2	0	2	0	2	0
25	2	0	2	0	..	..
26	..	..	..	..	..	..
27	2	0	2	0	2	0
28	2	0	..	..	..	..
29	..	..	..	..	..	..
30	..	..	..	..	..	..

Severe ataxia, followed by fit; external strabismus.

Severe ataxia, followed by fit; external strabismus.

Not exposed, as symptoms of poisoning still present.

Not exposed, as symptoms of poisoning still present.

Not exposed, as symptoms of poisoning still present.

Not exposed, as symptoms of poisoning still present.

Not exposed, as symptoms of poisoning still present.

Not exposed, as symptoms of poisoning still present.

Not exposed, as symptoms of poisoning still present.

Weight, 2,500 kilograms. Ataxic, and strabismus.

Not exposed.

Ataxia, etc.

Not exposed.

Not exposed.

Died with acute encephalopathy. Total turpentine evaporated during experiment 70 c.c. Post-mortem made at once.

Weight, 3,400 kilograms. Experiment not continued as turpentine animal died, and there were no lead-poisoning symptoms noted in this case. Chloroformed and post-mortem made.

No symptoms occurred throughout.

Post-mortem.—Cat No. 77, turpentine inhalation. Cadaver: not wasted; some bloody mucus about mouth; subcutaneous fat present, unaltered; muscles firm, hard, and unaltered. Mesenteric fat: present unaltered. Liver: dark, engorged with blood, congested, mottled diffuse bile staining; bile smells of turpentine; hæmorrhages. Lungs: bright cherry-red, similar to carbon monoxide poisoning; hæmorrhages in both bases; engorged with blood and smell strongly of turpentine. Heart: congested, but muscle normal; valves normal. Kidneys: perinephric fat normal; capsule strips easily; no violet odour; acute congestion and tubular nephritis. Stomach: recent hæmorrhages and mucous membrane thickened and congested. Small intestine: about 6 inches above cæcum, 5 inches of length contained recent blood and multiple ulcers. Large intestine: no dark staining as in lead poisoning, but melæna.

Histological examination of intestines, liver, and stomach showed recent hæmorrhages and ulceration, in intestines especially. Kidneys showed tubular nephritis.

In this table are detailed three parallel experiments. The experiments were so arranged that the same quantity of air was bubbled through each of the three bottles containing the fluid constituents of the paint. These three constituents were a part of the same mixtures that were used in the experiments described in Tables I and II. The three chambers were in parallel, but entirely separated from one another.

It will be observed that the linseed oil vapour produced no symptoms on the exposed animals, that the thinners and driers produced some effect, while the turpentine alone produced a very severe and pronounced effect. The "thinners" and "driers" consisted of turpentine and lead acetate.

It is evident that the symptoms exhibited by animals Nos. 76 and 77 are directly caused by the turpentine vapour carried into the chamber by the air bubbled through the fluid. The experiment further demonstrated that it is the turpentine moiety of the paint which causes the symptoms in animals exposed to the inhalation of vapour from freshly painted surfaces.

The toxicity of turpentine vapour when inhaled is further emphasized in the next series of experiments. Three animals were exposed to turpentine vapour for short periods, in the hope of rendering them gradually immune to the poisonous effects, with the object of determining if turpentine had any predisposing influence in the production of lead-poisoning. Unfortunately, no tolerance was developed by any of the animals experimented with; the three given in Table VII, on page 118, are typical of a number of other experiments.

These animals showed no tolerance of turpentine-vapour poisoning; even animal No. 88, which was apparently tolerant, was easily affected when the time of exposure was increased.

These experiments are confirmatory of No. 77 in Table VI, and the conclusion may be drawn that turpentine vapours, when inhaled in considerable concentration, may cause severe symptoms, and further, the effect on the kidney producing interstitial hæmorrhage and generalized nephritis is a significant fact, lead poisoning ultimately causing kidney affection when of long duration; and it is not at all improbable that turpentine vapour increases the susceptibility of painters to kidney disease and accelerates the action of lead upon those organs."

TABLE VII.

Further Toxicological Experiments with Turpentine Vapour to Determine if Tolerance Could be Produced in the Animal (Cat) to the Poison.

Day	Cat No. 88		Cat No. 90		Cat No. 94	
	Time exposed		Time exposed		Time exposed	
1	Hrs. 2	Mins. 0	Notes	Hrs. 2 Mins. 45	Notes	Hrs. 1 Mins. 40
2	2	0	Weight, 3,750 kilograms. No ill effect.		Weight, 3,350 kilograms. Animal died in acute ataxic condition with salivation (bloody).	Weight, 2,700 kilograms. Died in acute ataxic condition; rigidity of limbs, external strabismus; bloody salivation.
3	1	0	Ataxia in 1 hr.; salivation.		External strabismus.	
4	..	..	Slight ataxia; salivation.		Strangular.	
5	1	0	No exposure.		<i>Post-mortem</i> : Clot in right auricle, recent hæmorrhages in lung, liver, kidney.	<i>Post-mortem</i> : Recent hæmorrhages in lungs, liver, kidney. Brain acutely congested.
6	1	0	Slight ataxia; salivation.			
7	1	0	No effect except salivation.			
8	1	0	No effect except salivation.			
			Two weeks interval allowed and animal re-exposed.			
22	2	30	Animal died in acute ataxic state. External strabismus. Salivation. Sneezing.			
			<i>Post-mortem</i> : Recent hæmorrhages in all organs.			

Average quantity of turpentine evaporated per hour = 2.0 c.c. Cubic capacity of chamber = 300 litres, and exhaust ventilation changing air twelve times per hour = 2.0 c.c. per 3,600 litres = 0.0006 c.c. per litre approximately.

APPENDIX B

VAPOURS OR PARTICLES EMITTED BY LEAD PAINT¹

CONTRIBUTIONS TO THE STUDY OF LEAD INTOXICATION AMONG PAINTERS.

Dr. Herman has started experiments on the vexed question of vapours or particles emitted by lead paint.

1. A piece of filter-paper is hung above a fresh mixture of white lead and oil; the whole is covered with a bell-glass. After twenty-four hours, the filter-paper gives with H_2S the reaction of lead. But if the mixture of white of lead and oil is left to stand two days before the filter is hung above it, no lead is found in the filter-paper.

Conclusion: Lead vapours or particles are emitted from fresh lead paint; this emission ceases completely after forty-eight hours.

2. In a room (16 feet long, 13 feet broad, 17 feet high), a workman paints the four walls from the floor to a line situated 5 feet high. A sheet of filter-paper is wound round the head, neck and chest of the painter, who is under strict supervision in order to prevent him from touching the filter-paper with his fingers or brush. After two hours the work is finished, and on the paper three drops are plainly visible. The paper is left to stand for twenty-four hours over an osmic acid solution; forty-nine paint drops become visible, and this number is considerably increased if the paper is examined with a magnifying glass.

Conclusion: Painting a room emits a considerable number of very minute invisible paint droplets.

3. Four men paint the whole of the room. Twenty pieces of paper are hung for twenty-four hours at different heights and in different parts of the room. The papers hung in the upper part of the room do not give the reaction of lead; the others do at an increasing rate when nearing the floor.

Conclusion: The lead emission from a painted surface tends downward.

4. The room is painted again, and the air aspired through the keyhole passes in a glass tube containing two cotton-wool stoppers; then the air bubbles through diluted H_2SO_4 . After twenty-eight hours, the first stopper gives the reaction of lead; the second stopper and the H_2SO_4 do not.

Conclusion: The lead emission from a painted surface consists of particles, not vapours.

5. Atmospheric air is aspired through a series of three bottles: the first is half filled with water; the second (capacity 25 pints) has been internally painted, two hours before the experiment started, with white lead and oil; the third bottle is half filled with diluted H_2SO_4 . After ninety-six hours, the H_2SO_4 in the third bottle gives the reaction of lead. But if a cotton-wool stopper is put between the second and the third bottle, the stopper gives the reaction of lead, and the H_2SO_4 does not.

Conclusion: Two hours after the completion of work, a painted surface still emits very small droplets or particles containing lead, but no lead vapours.

¹ M. Herman, Bull. Acad. Med. Belg., July, 1914, and Scalpel, Aug. 10, 1919. Abst. Jour. Indust. Hygiene, Dec., 1919, p. 126 Sup.

APPENDIX C

AMOUNTS OF LEAD AND DUST PRODUCED BY SAND-PAPERING OF LEAD-PAINTED SURFACES AND BURNING OFF OLD PAINT.

Report on Dust found in Air of Workrooms.¹

(G. E. DUCKERING, Esq., H.M. Inspector of Factories.)

"In accordance with instructions, I have made determinations of dust and lead present in the air of workrooms during the sandpapering of lead-painted surfaces and also during the burning off of old paint. It was not possible to carry out the programme exactly as outlined owing to various circumstances, *e.g.*, burning off of old paint, though general, is very infrequent in any individual works, and in some trades is very rarely done. Sandpapering also, though general, occupies a small proportion only of the time spent in painting, and is invariably done in the early morning in order that the paint may be applied in the latter part of the day and have the night in which to dry. In some works, sandpapering is not done at all; in others, non-poisonous white lead is used, in others non-poisonous and leadless paints are used, and in some of the railway carriage works the coaches are varnished only. The amount of lead present in the air during sandpapering proved to be so high that modifications in the method of estimation of lead had to be made. For these reasons the investigation has taken longer than anticipated.

Processes in painting.

There are two principal general methods of painting used in the better class of work, such as for painting motor cars, coaches, railway coaches and locomotives, but each of these methods is capable of almost infinite variation in practice. The object in both cases is to get a hard and quite flat surface which will give a mirror-like effect after varnishing.

(1) *Sandpaper stopping or dry method.*

This method is the older but is rapidly going out of use. Its advantages are that it is cheaper than the wet method and it is also much more rapid. It does not, however, give such good results. The surface to be painted is (1) given from one to four coats of lead colour (*i.e.*, white lead mixed with gold size and turpentine, or with proprietary thinners and patent driers, and coloured gray by the addition of a little vegetable black). (2) Plastered over by means of a knife with a paste composed of dry white lead mixed with turpentine and a little gold size (sandpaper stopping). (3) Sandpapered by hand till the surface is flat and all the excess of stopping is removed. (4) Painted with one or two coats of lead colour. (5) Again lightly sandpapered. (6) Painted with two coats of the final colour. (7) Lightly sandpapered. (8) Painted with a coat of varnish colour. (9) Flatted by rubbing with a cloth and pumice powder and water or with a soft bony substance called cuttle fish. (10) Given two or three coats of varnish. Each coat of paint is, of course, allowed to dry before the application of another coat or before sandpapering, etc.

(2) *The wet method.*

The surface to be painted is (1) given from one to four coats of lead colour. (2) Painted with five to twelve coats of filling which is either a proprietary preparation or a mixture of slate powder with from none to 20 per cent. of white lead and with gold size and turpentine or with proprietary thinners. (3) Painted with one coat of staining which is usually a coat of filling of different colour. (4) Rubbed down with German stone or patent brick or pumice stone and water till the coat of staining is removed. (5) Painted with one coat of lead colour. (6) Stopped, *i.e.*, any cracks or scratches, etc., filled up with a paste composed of dry white lead mixed with gold size. (7) Faced by rubbing with pumice stone or patent brick and water. (8) Painted with one coat of lead colour. (9) Lightly sandpapered in order to remove "nibs," *i.e.*, any hairs or other foreign substances. It is then treated in the same way as in the first method described.

There are other methods of painting, but those described are most generally used.

In some works no sandpapering whatever is done, this process being replaced by rubbing with "cuttle fish" and water.

In the lower class work, such as painting by wheel-wrights, the surface is given three or four coats of oil paint, each coat being sandpapered, followed by a coat of varnish paint.

In railway wagon painting three coats of oil paint are applied. Sometimes the first coat is sandpapered, but in some cases this is omitted. In many cases non-poisonous white lead is used.

In painting motor car bonnets and wings (wheel guards) it is usual to give one coat of lead colour followed by sandpapering, and then proceed to give the final colours. The filling is in most cases (but not all) omitted.

¹ Appendices to the Reports of the Departmental Committees on Danger in Use of Lead in the Painting of Buildings and in Use of Lead Compounds in Painting, Enamelling and Varnishing of Coaches and Carriages, Vol. III, pp. 15-17.

In painting wooden wheels, whether for motor cars or for coaches, it is usual to sandpaper after each of two or more coats of lead colour. Filling is not generally done. For motor cars, wire wheels are coming into general use. These are japanned and not painted.

It is exceedingly difficult to estimate the time spent by workers in sandpapering. In a motor car works where the sandpaper stopping process is used, the following is an estimate by the workers themselves. It has been verified by reference to the manager:

Painter—Sandpapering from 1 to 2 hours per day.

Brush hand—Sandpapering from 2 to 3½ hours per day.

Painter's labourer—Sandpapering from 4 to 5 hours per day.

In other processes the time spent is too variable to give a reliable estimate, but apparently it varies from one-twentieth to one-sixth of the working hours.

Burning off old paint.

In the trades investigated, burning off old paint is an infrequent process. Usually the surface of a vehicle to be repainted is either rubbed down direct with pumice stone and water, or the varnish is removed by the application of alkaline liquids or a proprietary preparation, and the surface made flat by rubbing with stone and water. I was only able to find three cases of burning off in progress during the inquiry.

Determinations of dust and lead.

The method of determination of the dust and lead in the air was that described on page 201 of the Annual Report of the Chief Inspector of Factories for 1910. The estimates of the quantity of lead in the filters was made by the method described in Appendix XLIX of the Report of the Pottery Committee. In two cases where determinations were made during sandpapering of steel surfaces, the lead was estimated colorimetrically in acid solution and gravimetrically respectively. The filter was in every case placed as close as possible to the breathing point of the worker, but as the surfaces being treated were usually large, it was somewhat difficult to follow the rapid movements of the man engaged. As far as possible, however, the filter was moved as he moved.

Table I shows the whole of the results of the determinations, and for purposes of comparison the results of determinations of lead in pottery and tinning processes are shown in Table II. It will be seen that the amounts of lead in the air are enormous, being in many cases much in excess of the amounts found in the air even in wiping off in the tinning of hollowware.

TABLE I.

Dust and Lead in the Air at the Breathing Point of the Worker during Sandpapering and Dusting and Burning Off of Lead Paint.

Manu- facture or Trade (1)	Dust				Per- cent- age Lead in Dust (6)	No. of De- ter- mination	Process (7)	Remarks (8)
	Present in 10 cb.ms. of air (mgms.)		Found in Filter (mgms.)					
	Total Dust (2)	Lead (Pb.) (3)	Total Dust (5)	Lead (Pb.) (5)				
Railway coaches	206	53.7	6.7	1.75	26.1	1	Sandpapering and dusting	Passengers' fish truck after one coat of lead colour.
Railway coaches	241	116.1	5.2	2.50	48.1	2	Sandpapering and dusting.	Railway coach after one coat of lead colour on filled and faced surface.
Loco- motives	232	35.6	2.6	0.40	15.4	3	Sandpapering and dusting.	Locomotive after one coat of lead colour on filled and faced surface.
Railway wagons	353	53.4	9.9	1.50	15.2	4	Sandpapering and dusting.	Railway wagon after one coat of priming (lead colour).
Coach building	129	39.6	1.7	0.52	30.6	5	Sandpapering and dusting.	Coach body after one coat lead colour on filled and faced surface.
Coach building	453	83.1	10.9	2.00	18.3	6	Sandpapering	Coach wheel after two coats quick drying white lead paint.
Coach building	1,343	1,025.6	23.7	18.10	76.4	7	Dusting off.	Coach wheel after two coats quick drying white lead paint.
Coach building	362	99.7	8.7	2.40	27.6	8	Sandpapering.	Old cream painted wheel before repainting.

TABLE I.—Continued.

Manu- facture or Trade	Dust				Per- cent- age Lead in Dust	No. of De- term ination	Process	Remarks
	Present in 10 cb.ms of air (mgms.)		Found in Filter (mgms.)					
	Total Dust (2)	Lead (Pb.) (3)	Total Dust (4)	Lead (Pb.) (5)				
(1)	(2)	(3)	(4)	(5)	(6)		(7)	(8)
Coach building	28	3.9	0.5	0.07	14.2	9	Cleaning door.	Coach door. Cleaning with knife and sandpapering edges after filling and rubbing down (wet process).
Motor cars.	466	193.3	15.3	6.35	41.5	10	Sandpapering and dusting.	Sandpaper stopping process. After one coat of lead colour and stopping on steel panels of motor body.
Motor cars	206	135.8	4.4	2.90	65.9	11	Sandpapering and dusting	Steel wings of motor after one coat of lead colour.
Motor cars	396	182.6	6.5	3.00	46.2	12	Sandpapering and dusting.	Sandpaper stopping process. Bonnet boards after one coat of lead colour and sandpaper stopping.
Motor cars	600	278.3	6.9	3.20	46.4	13	Sandpapering and dusting.	Door of motor body after one coat of lead colour and quick drying sandpaper stopping. Urgent work.
Motor cars	615	258.7	10.1	4.25	42.0	14	Sandpapering and dusting.	Motor body after one coat of lead colour (quick drying), and stopped on filled and faced surface.
Motor cars	88	38.7	2.5	1.10	44.0	15	Sandpapering and dusting.	Wooden motor wheels after two coats of lead colour and sandpapering between and stopped (putty stopping). Exhaust not running.
Motor cars	35	4.7	0.9	0.12	13.3	16	Sandpapering and dusting.	Same point as 15, but with exhaust running.
Motor cars	52	2.8	1.5	0.08	5.3	17	Sandpapering and dusting.	Wooden motor wheels after one coat of lead colour and one coat of filling which is said to contain no lead.
Wheel- wright	277	36.9	6.0	0.80	13.7	18	Sandpapering and dusting.	Van wheel after one coat of flesh colour (oil paint).
Wheel- wright	494	143.8	10.3	3.00	29.1	19	Sandpapering and dusting.	Van wheel after one coat of quick-drying permanent red on two coats of flesh colour (sandpapering after each coat).
Wheel- wright	61	3.0	.02	0.01	5.0	20	Sandpapering and dusting.	Lorry backboard after one coat of lead colour.
Railway coaches	52	3.4	1.7	0.11	6.5	21	Burning off old paint.	White paint of London and North - Western coach. Gas burner used.
Loco- motives	69	1.2	2.2	0.04	1.8	22	Burning off old paint.	Red lake paint of Midland locomotive. Side of man towards which chips of burnt paint fly. Gas burner used.
Loco- motives	69	0.3	2.2	0.01	.05	23	Burning off old paint.	Same as 22, but opposite side of worker. Gas burner used.
Coach building	37	1.2	1.2	0.04	3.3	24	Burning off old paint.	Japanned coach body. Spirit lamp used.

TABLE II.

Lead in the Air at the Breathing Point of the Worker during Various Processes.

Process (1)	Lead present in 10 cubic metres of air (mgms.) (2)	Process (1)	Lead present in 10 cubic metres of air (mgms.) (2)
Tinning with open bath.....	37.8	Dipping china. Using dipping boards.....	2.1
Tinning with bath fitted with hood, etc.....	6.4	Dipping Rockingham ware....	2.3
Hollow-ware wiping after tin- ning. No exhaust.....	124.3	Cleaning earthenware. Exhaust applied.....	2.3
Dipping earthenware. Dipping boards not used.....	1.8	Cleaning china. Bad exhaust applied.....	13.3
Dipping earthenware. Using dirty dipping boards.....	6.3	Drying earthenware after dipping	2.2
		Earthenware glost placing....	2.1
		China glost placing.....	1.1
		Majolica painting and cleaning of tiles.....	9.1

8th May, 1911.

G. ELMHIRST DUCKERING.

APPENDIX D

AMOUNTS OF LEAD ACCUMULATED IN PAINTERS' OVERALLS.

Examination of Painters' Overalls.¹

Overall jackets, and in some cases, aprons and trousers, were obtained from 24 men employed by five firms, and examined by the Government Laboratory for the amount of lead present in them. The garments were in each case collected on a Saturday morning, and had been worn during a week of normal employment.

The Government Laboratory returns give separately:

- (a) Dust removed by beating;
- (b) Fine dust in pockets;
- (c) Total lead remaining after removal of (a) and (b).

Firm	Garment	Lead monoxide found in			Lead monoxide remaining in garment after removal of dust
		Dust removed by beating	Fine dust in pockets	Total dust	
		Mgms.	Mgms.	Mgms.	Mgms.
Styles and Son.....	Overall (T.E.J.).....	35.64	58.97	94.61	3589.92
" ".....	Overall (C.F.).....	20.73		20.73	3207.60
" ".....	Overall (C.K.).....	78.41	3.24	81.65	4160.16
" ".....	Overall (H.F.).....	10.37		10.37	1380.24
" ".....	Apron (H.F.).....	12.96	0.65	13.61	1632.96
" ".....	Overall (T.V.).....	68.69	101.09	169.78	7225.20
" ".....	Apron (T.V.).....	29.81	2.59	32.40	5216.40
" ".....	Overall (W.S.).....	29.81	16.85	46.66	1354.32
Green & Abbott.....	Overall (W.L.M.).....	53.14		53.14	3045.60
" ".....	Apron (W.L.M.).....	2.79		2.79	673.92
" ".....	Overall (J.G.S.).....	20.09	9.72	29.81	745.20
" ".....	Apron (J.G.S.).....	5.83		5.83	745.20
" ".....	Overall (C.M.).....	12.96	8.42	21.38	816.48
" ".....	Apron (C.M.).....	3.89	1.94	5.83	1334.88
" ".....	Overall (J.W.).....	11.66	16.85	28.51	1801.44
" ".....	Apron (J.W.).....	Traces		Traces	278.64
" ".....	Overall (T.H.).....	60.35	18.79	79.14	2183.76
" ".....	Apron (T.H.).....	81.65		81.65	2928.96
" ".....	Overall (A.O.).....	6.48		6.48	1082.16
" ".....	Apron (A.O.).....	145.80	456.84	602.64	3468.24
Maple & Company.....	Apron (R.B.).....	27.22	29.16	56.38	5676.48
" ".....	Jacket (T.R.H.).....	25.29	7.13	32.42	5754.24
" ".....	Trousers (T.R.H.).....	22.03		22.03	3998.16
" ".....	Overall (W.F.).....	20.74		20.74	5728.32
" ".....	Overall (A.E.M.).....	41.47	58.49	99.96	7367.76
" ".....	Overall (D.K.).....	68.04		68.04	6946.56
" ".....	Apron (D.K.).....	112.75		112.75	10128.24
" ".....	Overall (G.S.B.).....	53.78	125.23	179.01	10069.92
L. & S.W. Ry., Richmond	Overall (S.P.).....	4.54		4.54	544.32
" ".....	Apron (S.P.).....	46.66		46.66	1820.88
" ".....	Overall (A.V.).....	1.94	0.65	2.59	771.12
" ".....	Apron (A.V.).....	1.94		1.94	583.20
" ".....	Overall (C.W.).....	29.16		29.16	2702.16
" ".....	Apron (C.W.).....	37.58	41.47	79.05	5670.00
" ".....	Overall (A.J.H.).....	37.58		37.58	1043.28
" ".....	Apron (A.J.H.).....	10.37		10.37	1807.92
W. Hennessy & Sons....	Overall (C.N.).....	7.13	7.13	14.26	265.68
" ".....	Trousers (C.N.).....				51.84
" ".....	Overall (H.J.E.).....	12.96		12.96	673.92
" ".....	Apron (H.J.E.).....	7.13		7.13	907.20

¹ Appendix to Reports of the Departmental Committees on Danger in Use of Lead in the Painting of Buildings and in Use of Lead Compounds in the Painting, Varnishing and Enamelling of Coaches and Carriages, Vol. III, p. 39

The method of examination was described as follows in the Government Laboratory report:

"The overalls and aprons were beaten so as to remove loosely adhering dust, the treatment being similar to that which the garments would receive when shaken in the ordinary way. Before beating, the pockets were turned out and any dust in them was removed and passed through a sieve with 60 meshes to the linear inch. The fine dust from the pockets was examined for lead separately. The coarser portion, as a rule, consisted of cigarette ends, tobacco, fluff, and dirt, and was not examined.

"After removal of the dust, the garments were gently incinerated and the lead in the ash determined. The quantity of lead found is given above in the column headed 'Lead after removal of dust,' and represents the amount of lead which the garment would retain after vigorous shaking had removed all the dust."

APPENDIX E

CHEMICAL EXAMINATION OF LEAD GLAZES.¹

(POTTERY INDUSTRY)

"The procedure and the technique followed at the Hygienic Laboratory for the determination of the amounts of the soluble and the total lead content in the glaze samples are here given. Although not all the samples were analyzed at this laboratory, the method outlined is similar to that used in the other laboratories.

Handling of samples.

"The preliminary handling of the samples depends entirely on whether the sample is received in the powdered form or suspended in a liquid. The powdered samples are thoroughly ground in a mortar with a pestle until the lumps are broken. The thoroughly mixed sample is then transferred to a stoppered bottle. The samples suspended in liquid are kept stoppered in the original containers, but are thoroughly shaken before analysis is made.

Determination of water.

"In the powdered samples: weigh 5 grams of the powdered sample into a tarred porcelain dish and dry at 100° C. until there is no further loss of weight. The loss in weight will represent the water present. The resulting dried sample is then transferred to a glass-stoppered bottle and reserved for determination of lead.

"In the liquid samples: After thoroughly mixing the sample in the bottle, weigh 10 to 20 grams of the sample into a tarred porcelain dish and dry at 100° C. until residue can be powdered with a spatula. After the dry residue in dish is broken with a spatula, return the dish and sample to oven again and dry at 100° C., until there is no further loss in weight. The loss in weight will represent the water present. The resulting dried sample is then transferred to a glass-stoppered bottle and reserved for determination of lead.

Determination of soluble lead.

"Weigh in duplicate 0.15 gram of the dried sample into a glass-stoppered bottle and, after adding 150 c.c. of 0.25 per cent. hydrochloric acid, shake for one hour in a shaking machine at a rate of 200 excursions per minute. Transfer contents of bottle to a 200 c.c. volumetric flask and dilute to mark with water. After one hour of standing, filter the sample and transfer 100 c.c. aliquot to a 300 c.c. Erlenmeyer flask. Add 2 c.c. of N/5 acetic acid, saturate with hydrogen sulphide, and allow to stand over-night under bell jar. Filter, transferring entire precipitate with aid of first filtrate. Wash the precipitate six times with 10 c.c. portions of a solution of H₂S containing 10 c.c. of saturated aqueous solution of H₂S, 100 c.c. of water, and 5 c.c. of N/5 acetic acid. Return the filter containing the precipitate to the original Erlenmeyer flask and add 20 c.c. of 1-10 HNO₃. Place a funnel in the mouth of the flask and boil moderately for five minutes. Filter, wash residue six times with about 10 c.c. each of hot water, and evaporate filtrate on steam bath to about 10 c.c. Cool, add 5 c.c. of concentrated sulphuric acid, and heat until copious SO₃ fumes are given off. Cool, dilute with 5 c.c. of water, and add 150 c.c. of 50 per cent. alcohol. Mix and allow to stand overnight. Filter through a tarred Gooch crucible and wash six times, filling the crucible each time with 50 per cent. alcohol, finally washing with 10 c.c. of 95 per cent. alcohol. Dry the crucible and lead sulphate two and one-half hours at 100° C., and weigh. The increased weight of crucible is the lead sulphate. Using the factor 0.6832, calculate the per cent. of soluble lead in the sample.

Determination of total lead.

"Weigh 1 gram of the dried sample into a 100 c.c. casserole, add 30 c.c. of 1-1 nitric acid, and evaporate to dryness on steam bath. Take up residue with hot water and filter, washing the residue on filter paper with hot water. Reserve filtrate for combination with filtrate from fusion of residue. Transfer residue and filter paper to platinum crucible, dry, and ignite cautiously until paper is nearly ashed. Add 4 grams of fusion mixture (5 parts Na₂CO₃ and 7 parts K₂CO₃) to residue in crucible, and fuse until fusion is complete. Remove crucible to casserole and dissolve the fused sample in a weak aqueous solution of HCl until crucible is clean. Filter the resulting solution and wash residue on filter paper until free of solids. Combine the filtrate with above filtrate, evaporate, and transfer the combined filtrate to a 200 c.c. volumetric flask. Dilute to mark and mix thoroughly. Take two 40 c.c. aliquots and evaporate to dryness in 200 c.c. casserole. Add 30 c.c. of 1-1 HNO₃ and evaporate to dryness again. Take up with hot water and transfer to 300 c.c. Erlenmeyer flask, diluting to 100 c.c. mark. Add 5 c.c. of N/5 acetic acid, saturate with H₂S, and allow to stand overnight under bell jar. Filter the lead sulphide, and follow the same procedure as given under the determination of soluble lead, weighing the lead sulphate and calculating the per cent. of total in the sample."

¹ B. J. Newman, W. J. McConnell, O. M. Spencer and F. M. Phillips, Lead Poisoning in the Pottery Trades, U.S.P.H.S., 1921, P. H. Bull. No. 116, pp. 191, 192.

APPENDIX F

STUDIES OF EMANATIONS FROM LEAD GLAZE*

(POTTERY INDUSTRY)

The theory that there are emanations and tension of fumes of the carbonate and the oxides of lead has been investigated by a chemist of the U.S.P.H.S. in regard to the possibility of fumes from open tubs of pottery glaze.

"In our efforts to evaluate all the factors which perchance might help to explain the higher incidence of lead poisoning among the dippers, our attention was attracted to J. L. Breton's¹ statement that his experiments, as well as those of M. Trillat, Dr. Heim and others, proved the emanations and tension of fumes of the carbonate and the oxides of lead. Since these compounds are used in the glaze, it occurred to us that if emanations are given off from the glaze in the open tubs over which the dipper stands, he is exposed to an added hazard. This led to the following study and experiments by Assistant Chemist Harry W. Houghton, of this office, who conducted the work at the Hygienic Laboratory:

"In the search for literature pertaining to the hazards of the pottery industry there was found a publication by Breton¹ in which the author described in detail the discovery of emanations from fresh white-lead paint, by the detection with acetic acid solution, of tetramethyl-diamino-diphenylmethane, Trillat's reagent, which produced a blue colour with lead peroxide. The same author cited four other similar investigations, among which were emanation studies on the oxide and carbonate of lead, but in only one of these investigations did the results confirm his experiments. In the majority of the investigations no emanations were found. Although there has been an evident diversity of opinion as to the existence of emanation from lead compound, no further investigation has been undertaken since this publication in 1911.

"Since some of these lead compounds declared by Breton to give off emanations were present in lead glazes used in the pottery industry, it was decided to repeat these experiments in order to determine whether such glazes produce emanations; for if they do so, these emanations undoubtedly present another hazard to workers in pottery.

Historical Review.

"In 1903 Breton¹ conducted a series of experiments for the determination of emanations from fresh white-lead paint, by detection with tetramethyl-diamino-diphenylmethane,[†] which when dissolved in acetic acid (Trillat's reagent) gave a distinct blue colour with peroxide of lead, resulting in the formation of the corresponding hydrol, $\text{C}_6\text{H}_4\text{N}(\text{CH}_2)_2$.

"About the same time the problem was worked on by several other investigators, among whom were Trillat², Bezançon³, Gautier,⁴ and Heim and Hébert.⁵ Most of these investigators, excepting only Breton and Heim and Hébert, obtained no emanations. The bacteriological studies conducted by Trillat² and Marie⁶, in which the bacterial culture were incubated in chambers freshly painted with white-lead paint, showed in the majority of the experiments that there was a retardation of the bacterial growth.

"Trillat reported that he did not obtain any indication of lead emanations, chemically, using the reagent prepared from tetramethyl-diamino-diphenylmethane; yet Breton conducted similar experiments, spreading the white-lead paint over a large area, and obtained positive evidence of small amounts of lead emanations.

"In his studies, Breton arranged a series of freshly-painted boxes under a bell jar in such a manner as to allow a current of air to circulate and be exhausted through a tube connected with an absorption chamber containing 10 per cent. sulphuric acid which held the lead emanations. The sulphuric acid solution was evaporated to dryness, and lead sulphate was obtained, which was later reduced to lead peroxide by treatment with alkaline hypochlorite. It is supposed that the remaining lead peroxide was washed free of chlorine and hypochlorite and was then dissolved in acetic acid and tested with Trillat's reagent, the production of a blue colour showing the presence of lead emanations.

* B. J. Newman, W. T. McConnell, O. M. Spence and F. M. Phillips, U.S.P.H.S., P. H. Bull, No. 116, 1921, pp. 193-197.

¹ J. L. Breton, *Les Maladies Professionnelles*, Encyclopedie Parlementaire, Paris, 1911, 89.

² *Ibid.*, Le Plomb, Encyclopedie Internationale Hygiene (1ere Serie), Paris, 1900, chapitre II.

[†] This tetramethyl base was prepared as follows: A mixture composed of 30 grams of dimethylaniline, 10 grams of formaldehyde, and 200 c.c. of 5 per cent. sulphuric acid solution was heated on a water bath for one hour. After the mixture cooled, an excess of sodium hydroxide was added, and the excess of dimethylaniline and the trace of amine were removed by passing a strong stream of steam through the mixture for 10 minutes. When it had cooled, a mass of crystals settled out, which were removed and recrystallized in alcohol. This procedure gave 15 to 20 grams of the base. The preparation of this base is also given in Farbstoff-Tavellen (1914), by G. Schultz, p. 168.

² Trillat, cited in publications by J. L. Breton.

³ Bezançon, cited in publications by J. L. Breton.

⁴ Gautier, cited in publications by J. L. Breton.

⁵ Heim and Hébert, Rapport Breton sur l'Emploi des composés de plomb, No. 799, Annex XV, pp. 825, 828.

Heim and Hébert, Bull. Sc. Pharmacology, 16, 272-274, Chem. Abstract V, 1911, 647.

⁶ Marie, cited in publications by J. L. Breton.

"Heim and Hébert followed the procedure of Breton to a certain extent, but outlined a method which showed a tension of vapours from carbonate and oxide of lead. The technique of these authors was as follows: The air was first drawn through absorption tubes containing sulphuric acid and caustic potash, to free it of all acid or basic vapours which might be present in the atmosphere; then through a long tube (1-2 cm. in diameter) in which was placed the lead compound, held at the proper temperature; if the compound was in the pulverized form, the two extremities of the tube were closed with cotton plugs to prevent the passage of any dust; the air was then let through a U-tube filled with cotton, which also served to retain any dust; and then into a Gautier absorption tube, in which was placed 10 c.c. of sulphuric acid, which held the emanation of lead; the air was finally passed through a gas meter in order to measure the rate of flow of air that passed through the apparatus. From 3 to 4 litres of air were allowed to pass through per hour. As soon as 100 litres had passed through the apparatus, the absorption tube containing the sulphuric acid was removed, and the sulphuric acid was thoroughly washed from the absorption tube. This acid solution containing the lead emanations was evaporated to dryness, leaving the lead in the form of lead sulphate. The dry residue was treated with a solution of sodium hypochlorite, which reduced the lead sulphate to lead peroxide. The chlorine was removed by calcination or washing. On adding the Trillat reagent directly to the residue of lead peroxide there was obtained a characteristic blue colour, which was determined colorimetrically by comparison of intensity of colour with similar colour produced by known amount of lead peroxide likewise treated. Traces of manganese and copper gave similar colour reaction, but these were removed from the lead sulphate by washing.

"Through this procedure, Heim and Hébert studied first the emanations given off from 10 grams of metallic lead filings mixed with 150 grams of emery, and they obtained 0.5 and 1 milligram of lead as emanations per 100 litres of air, at temperatures of 18 degrees and 100 degrees respectively. The same quantity of pure lead and solder or type alloy in fusion showed, respectively, 0.4 and 0.3 milligram of lead emanation per 100 litres of air. The results of these experiments showed that lead filings heated to 18 degrees and 100 degrees gave off more emanations than the molten pure lead, solder, and type alloy.

"In other experiments in which they used 100 grams of ground emery and a quantity of white lead corresponding to 10 grams of metallic lead, Heim and Hébert obtained the following results, at a temperature of 15 to 20 degrees, namely, 0.15, 0.20 and 0.12 milligram of lead per 100 litres of air. These investigators concluded that their experiments verified those of Breton.

"Preliminary Experiments

"As a preliminary to the determination of emanations from the lead glazes, it was necessary, since neither of the procedures described by Breton and by Heim and Hébert was sufficient in detail to permit exact repetition of these experiments, to conduct a few experiments in order to ascertain the exact conditions which must exist in order to reduce the lead sulphate completely to lead peroxide, and also to remove all traces of oxidizing agents, such as chlorine, ozone, etc., derived from the sodium hypochlorite solution, after acidifying.

"In the first experiment, portions of prepared lead sulphate were treated with sodium hypochlorite, first without heating, and secondly by boiling; but neither of these processes reduced the lead sulphate to peroxide. In subsequent experiments the sodium hypochlorite solution which was added to the lead sulphate was heated nearly to boiling. This procedure brought about the proper reduction of lead sulphate to peroxide.

"The experiments next conducted were to determine the treatment that must be followed in order to remove all oxidizing agents given off from sodium hypochlorite when acidified, since these gases also produced a blue colour with Trillat's reagent. When the lead sulphate had been reduced to lead peroxide, after the procedure just described, the remaining sodium-hypochlorite solution was acidified with nitric acid. This acid solution was then filtered and the residue was washed until the filtrate was free from chlorides and acid. Considerable washing was required in order to remove all compounds which gave a blue colour with the Trillat reagent, except the lead peroxide. The residue on the filter paper was then dissolved in acetic acid and tested with the Trillat reagent.

"Having finally worked out a procedure which would give somewhat dependable results, the following method of analysis was adopted:

"*Apparatus.*—The apparatus consisted of a series of absorption tubes, one Erlenmeyer flask, and a gas meter, connected with glass tubing in such a manner as to permit a known amount of air to be drawn through the apparatus.

"The air was first passed through two absorption tubes—one of which contained sulphuric acid, while the other contained caustic potash—thus removing any acid or basic vapour which might be present in the atmosphere; from these absorption tubes the air was led into a stoppered Erlenmeyer flask (1,000 c.c. capacity) to within 1 inch of the bottom, so as not to come in contact with the lead glaze which was in this flask; the air was then drawn from the Erlenmeyer flask through a U-tube filled with cotton batting, which served to prevent the escape of any dust from the sample of lead glaze; the air was then passed through a Geissler absorption bulb containing 10 c.c. of concentrated sulphuric acid, which dissolved the emanation of lead glazes; finally the air passed through a gas meter, which enabled the measurement of the flow of air through the apparatus.

"*Method.*—An amount of the lead glaze equivalent to 10 grams of metallic lead was weighed out and placed in the Erlenmeyer flask. Before the apparatus which has just been described was

put in connection, the Erlenmeyer flask was rotated so as to spread the glaze over the entire interior surface of the flask. After a tight connection on the apparatus had been made the air was permitted to flow over the lead glaze at a rate of 6 litres an hour for a period of 24 hours. At the end of this time, the Geissler bulb containing the sulphuric acid was disconnected, and the acid was thoroughly removed from the bulb to an evaporating dish, with water. The acid solution, which was evaporated to dryness, was treated with 20 c.c. of sodium-hypochlorite solution heated nearly to boiling point. This solution was then acidified with nitric acid and filtrated. The residue on the filter paper was thoroughly washed until filtrate was free of chlorides and acid. The lead peroxide on the filter paper was dissolved in a small amount of acetic acid and tested with Trillat's reagent. The productions of a blue colour indicated lead peroxide.

EXPERIMENTAL DATA

Experiment No. 1 (lead glaze No. 16).

Per cent. of water present.....	43.31
Per cent. of total lead present.....	7.88
Per cent. of soluble lead present.....	6.09
Weight of sample taken.....	grams 12.69
Volume of air aspirated per 24 hours.....	litres 144.00
Temperature of air during period of experiment.....	degrees 18.22
Amount of lead emanations obtained.....	None

Experiment No. 2 (lead glaze No. 19).

Per cent. of water present.....	35.34
Per cent. of total lead present.....	14.40
Per cent. of soluble lead present.....	13.01
Weight of sample taken.....	grams 69.50
Volume of air aspirated per 24 hours.....	litres 144.00
Temperature of air during period of experiment.....	degrees 18.22
Amount of lead emanations obtained.....	None

Experiment No. 3 (lead glaze No. 39).

Per cent. of water present.....	0.62
Per cent. of total lead present.....	17.85
Per cent. of soluble lead present.....	9.77
Weight of sample taken.....	grams 56.02
Volume of air aspirated per 24 hours.....	litres 144.00
Temperature of air during period of experiment.....	degrees 18.23
Amount of lead emanations obtained.....	None

Experiment No. 4 (lead glaze No. 41-2).

Per cent. of water present.....	30.17
Per cent. of total lead present.....	26.67
Per cent. of soluble lead present.....	None
Weight of sample taken.....	grams 37.50
Volume of air aspirated during 24 hours.....	litres 144.00
Temperature of air during period of experiment.....	degrees 20.22
Amount of lead emanations obtained.....	None

Experiment No. 5 (lead glaze No. 41-b).

Per cent. of water present.....	43.68
Per cent. of total lead present.....	25.49
Per cent. of soluble lead present.....	23.47
Weight of sample taken.....	grams 39.20
Volume of air aspirated during 24 hours.....	litres 144.00
Temperature of air during period of experiment.....	degrees 20.23
Amount of lead emanations obtained.....	None

"Discussion.

"The oxidizing agents, such as chlorine and ozone, which were liberated from the sodium hypochlorite and lead peroxide by the addition of nitric acid, were entirely separated from the remaining lead peroxide by filtration, followed by a thorough washing until the filtration was free of chlorine and acid. As a check on the complete removal of these oxidizing agents, there were run each time control experiments, using 20 c.c. of sodium hypochlorite with and without 0.2 milligram of lead sulphate, which is the compound of lead obtained by evaporating the sulphuric acid, if there were any emanations given off from lead glazes. In each of the five experiments conducted to determine the emanations from lead glazes the final test with the Trillat reagent was negative, agreeing exactly each time with the test made of the blank experiments. But in the experiments where 0.2 milligram of lead sulphate was treated with the sodium hypochlorite solution and the resulting lead peroxide was filtered and washed free of oxidizing agents, such as chlorine and ozone, there was obtained each time a positive test for lead peroxide, indicated by the distinct blue colour produced with the Trillat reagent.

"The absence of emanations from lead glazes might be accounted for by the fact that some glazes were mixed with 30 to 43 per cent. of water, which would tend to prevent any emana-

tions. Yet this is hardly true, for in most of the experiments the water evaporated during the aeration period. Even in the cases where the water evaporated, there were present no indications of emanations. The result of these experiments agreed with those obtained by Experiment No. 3, in which was used a glaze containing 0.62 per cent. of water.

"Furthermore, the absence of emanations in these experiments, as shown by chemical detection with Trillat's reagent, *i.e.*, 5 per cent. acetic acid solution of tetramethyl-diaminodiphenylmethane, agreed with the results of Trillat, Bezançon, and Gautier (*loc. cit.*), although it disagreed with the results obtained by Breton and Heim and Hébert (*loc. cit.*), in spite of the fact that the technique followed was nearly identical with that stated to have been used by the latter investigators. In the method followed by Heim and Hébert, it was stated that the chlorine was removed from the lead peroxide and the sodium hypochlorite solution by calcination or by washing with water. Both these procedures were found to be impracticable. Calcination and boiling, if sufficient to remove the chlorine, destroyed the lead peroxide, while the removal of the chlorine by washing was found to be practically impossible, since in the effort to remove the last traces of chlorine from such small amounts of lead peroxide as 0.1 to 0.2 milligram and also to free the interior of the beaker of adhering hypochlorite and free chlorine, the lead compound was lost by suspension in the wash water. Unless all the chlorine and hypochlorite were removed from the beaker, the Trillat reagent would turn blue in the absence of lead peroxide because of the chlorine gas set free from the hypochlorite by its acidifying with acetic acid contained in the Trillat reagent. In addition to the chlorine gas, which produced a blue colour with the Trillat reagent, traces of ozone would also be present, which would likewise produce a blue colour, according to the results stated by Arnold and Mentzel¹ and Fischer and Marx.² The ability of Trillat's reagent to detect oxidizing agents as well as lead peroxide rather offsets its use as a reliable test for lead, especially where such small amounts of lead peroxide and gases were present.

"Conclusions.

"1. There were no emanations given off from the five lead glazes that were studied.

"The Trillat reagent, which was used for the detection of lead peroxide, was found to be extremely sensitive likewise to such oxidizing agents as chlorine and ozone.

"3. Unquestionable detection of lead emanations as lead peroxide from lead compounds must absolutely be determined in the absence of chlorine and ozone, if Trillat's reagent is used for the detection."

"The above conclusions by Harry W. Houghton indicate that no lead hazard exists from emanations arising from tubs filled with glaze."

¹ Arnold & Mentzel, *Ber. d. deutsch. Chem. Ges.* 35, 1902, 1324.

² F. Fischer & Marx, *Ber. d. deutsch. Chem. Ges.*, 39, 1906, 2555.

CHAPTER VII

TREATMENT

Treatment may be considered under two heads: (1) prophylactic medical measures, aiming at supplementing the broader preventive methods dealt with elsewhere, and applicable to all lead workers, especially those in the pre-saturnine stage, and (2) curative treatment, applicable to those who are definitely suffering from plumbism, in one form or another.

(1) Prophylactic treatment*(a) Fresh air, change of occupation, etc.*

Workers who seem to be on the border line between the lead absorption period and actual lead intoxication should be encouraged to get as much fresh air as possible. Oliver¹ refers to the importance of interrupting their absorption of lead, and says, "It would be a prudent act on the part of factory surgeons and employers to give workmen who, judging from pre-saturnine cachexia, are thus brought to the verge of breaking down in health, a holiday for a fortnight two or three times a year, so that absorption of lead might be interrupted and elimination promoted."

Where, as usually, such measures are impracticable, temporary transference to outdoor work is recommended.

(b) Aperients.

In order that elimination of lead may be promoted, it is especially important for lead workers to keep their bowels moving regularly. For this purpose, plants should provide some approved aperient, such as epsom salts, and should instruct employees in its value. Legge and Goadby² recommend "saline composed of sodium sulphate and magnesium sulphate."

Oliver³ refers to one factory which daily supplies the men with chocolate-coated tabloids containing sulphide of soda.

Marvin Shie⁴ refers to factories which similarly supply 1 grain calcium sulphide tablets daily, and adds, "it is reported that the incidence of plumbism is less in these plants than in those in which the drug is not used."

(c) Sanitary drinks.

Many plants provide some form of acidulated drink for lead workers, and English laws require such provision for certain lead processes. Legge and Goadby⁵ recommend "the use of some type of lemonade containing sodium citrate," as tending to diminish the "increased viscosity of the blood" produced by lead absorption.

(1) Curative treatment*(a) Anæmia.*

Suspension from work and facilities for being in the open air are the best treatment. Oliver⁶ also recommends "a mild iron tonic, with or without magnesium sulphate."

1 Oliver, Lead Poisoning, 1914, p. 202.

2 Legge and Goadby, Lead Poisoning and Lead Absorption, 1912, p. 185.

3 Oliver, Lead Poisoning, 1914, p. 207.

4 Marvin, Shie, Industrial Lead Poisoning, Jour. Am. Med. Assoc., March 26th, 1921, p. 840.

5 Legge and Goadby, Lead Poisoning and Lead Absorption, 1912, p. 186.

6 Oliver Lead Poisoning, 1914, p. 209.

(b) Colic.

For the pain, simple remedies, such as the application of heat to the abdomen, should be tried, but in severe cases, hypodermic injections of morphia may be necessary.

Gilman Thompson¹ considers belladonna (M v) useful and recommends the following combination:

R̄ Tincturæ cardamomi compositae.
Aquæ menthæ piperitæ.
Spiritus ammoniæ aromatici, ā ā ʒ i.

M. Sig. Give ʒ i every two hours in a wineglassful of hot water.

He also refers to chlorotone (gr. v) and chloroform water (℥ xx) as useful remedies.

Oliver² states that abdominal pain continuing over days can be relieved by $\frac{1}{2}$ or 1 grain sodium monosulphite doses taken 3 or 4 times daily. He has also had good results from giving $\frac{1}{4}$ grain doses of permanganate of calcium thrice daily.

For constipation, castor oil is usually ordered. In extreme cases Oliver³ recommends croton oil in 1 drop doses, but says, "1 ounce of olive oil in warm milk taken by the mouth, or a rectal enema of olive oil and warm water should be tried first." Legge and Goadby⁴ say that, "it is far better in obstinate cases of constipation and colic to give enemata than to continue with the huge doses of salines or other aperients, such as croton-oil, elaterinum, or castor oil."

Marvin Shie⁵ suggests that "benzyl benzoate, an opium alkaloid of the benzyl-isoquinolin group . . . may readily become the sovereign remedy for the constipation and colic of lead poisoning." He refers to the researches of Macht and of Litzenberg, which "have shown that this drug counteracts remarkably well the spasm of smooth muscle. They have also shown that ureteral colic, excessive intestinal peristalsis and spastic constipation yield to the tonus-lowering antispasmodic effect of the drug."

Administration of potassium iodide: Need of care.

With regard to the administration of potassium iodide, a mixture of which with magnesium sulphate is sometimes ordered for cases of colic, Oliver⁶ is among those who disapprove of the administration of potassium iodide as a "routine treatment" on the grounds that it may actually intensify the disease since it "has the power of dissolving lead which has been lying inert and stored in the tissue, of causing it to circulate in the blood."

(c) Wrist drop

Massage and electricity are the chief forms of treatment commonly recommended. Oliver⁷ says that these may be supplemented by "internal administration of 2 or 3 minims of liquor strychniæ, or 5 minims or more of tincture of nux vomica. To the nux vomica mixture a few grains of iodide of potassium may be added." (See, however, in this connection, the warning against too free an administration of iodide of potassium under the heading "Colic," above.)

¹ Gilman Thompson, *The Occupational Diseases*, 1914, p. 284.

² Oliver, *Lead Poisoning*, 1914, p. 210.

³ *Ibid.*

⁴ Legge and Goadby, *Lead Poisoning and Lead Absorption*, 1912, p. 187.

⁵ Marvin Shie, *Industrial Lead Poisoning*, *Jour. Am. Med. Assoc.*, March 26th, 1921, p. 840.

⁶ Oliver, *Lead Poisoning*, 1914, p. 210.

⁷ *Ibid.*, p. 211.

(d) Epileptiform convulsions

Treatment consists of administration of hypnotics by mouth or rectum, inhalation of amyl nitrate and chloroform, and, as added by Oliver and Thompson, performance of lumbar puncture.

Value of salicylate of sodium as eliminant and analgesic

Dr. A. B. Somers, who had thirty years' experience as surgeon and physician to the American Smelting and Refining Company, Omaha plant, used dramme doses of salicylate of sodium. He considers that at the beginning of treatment it assists in eliminating poisons and to some extent lessens the necessity for morphine in colic.

Use of sodium iodid, magnesium sulphate and calcium sulphid

"The therapeutic efficiency of some agents in current use for the treatment of chronic lead poisoning was tested by Hanzlik and Presho in pigeons. Using sodium chlorid as control, the daily administration of sodium iodid in food and drinking water, and of magnesium sulphate and calcium sulphid in food, in doses corresponding to medium and large therapeutic doses, were found to be beneficial. This agrees generally with the clinical results obtained with these agents in the treatment of chronic lead poisoning in man. The beneficial effects of magnesium sulphate are due in part, at least, to its cathartic action. The beneficial therapeutic effects of all agents tested are attributed partly to the diminished solubility of the lead and, therefore, diminished absorption."¹

Oliver's claim that the double electrical bath treatment removes lead from the body and should accordingly be used for preventive and curative treatment²

Oliver strongly recommends double electrical bath treatment as a means of removing lead from the body. Despite the difficulty in proving that the lead found on the electrodes in the bath in which the patient has been immersed has actually been extracted from the body and is not merely surface lead, which may have been on the skin, or lead in the water from the pipes, Oliver, after experiments with animals and investigations with lead workers, believes that extraction does take place. His account of the method is as follows:

"The theory of the action of the double electrical bath is as follows: when an electrical current is passed through a solution of a salt, the acid radicle collects upon the positive pole while the base travels to the negative. Thus

$\frac{\text{NaCl}}{\text{ZnSO}_4}$ after passage of an electrical current appears as $\frac{\text{Cl}}{\text{SO}_4}$ at the positive pole

and $\frac{\text{Na}}{\text{Zn}}$ at the negative. The two entities in each salt are called *ions*. They

possess the power of traversing membranes. When a solution containing them is applied to the skin, and an electrical current is passed at the same time, *ionization* occurs. Introduction of metallic drugs into the human body by this means has been attended with distinct success. The method of application is as follows: The joint or limb about to be treated can either be placed in a bath containing the salt in solution, or a pad of lint soaked in the medicament can be laid upon the particular part, and an electrode laid upon it, while the other pole is applied to an indifferent part of the body. If a bath is used, more current can be passed, and as a consequence more ions can be introduced. Such in a few words is ionization.

¹ Abstracted Jour. Amer. Med. Assoc., 5. 5. 23, 80, No. 18, p. 1341, from Jour. of Pharm. and Exper. Therapeutics, Baltimore March, 1923, 21, p. 131.

² Oliver, Lead Poisoning, 1914, pp. 215-217.

Electrical treatment of lead poisoning by the two-bath system is de-ionization. In this method of treatment the electrical current passes through the body: it breaks up any lead compound which may be present; it carries the acid radicle to the positive pole, and the base to the negative. The apparatus is simple. A wooden tub is required for the feet of the workman, and into it tepid water is placed, while for the hands and forearms similar provision is made. A series of tubs can be arranged so that several men can take the bath at one and the same time. The electrical part of the apparatus consists of a battery, a milliampère-meter, and a rheostat for regulating electrical pressure, also wires and electrodes in the form of grids. The bath is given for half an hour or a little longer every day or every second or third day, according to whether it is being used for curative or preventive purposes. A voltage of 16 is generally sufficient, and a milliampère-age of 20 to 40. The positive pole is placed in the foot-bath, and the negative in the arm-bath. The electrodes, made from aluminum, should be free from lead. If the electrical current, as regulated by the rheostat, is introduced gradually, no shock is felt, nor is any unpleasant sensation experienced by the men. On the other hand, if the hands or feet are brought into direct contact with the electrodes, the skin may become red and painful, and ulceration even may follow. Care must therefore be taken by those using the bath that such accidents do not occur. Occasionally the skin becomes red and irritable at the water-level mark, due to disruption of the common salt added to the bath-water to reduce resistance to the passage of the electrical current."

The amounts of lead removed are, of course, minute, one-eighth grain in the first bath, one-fifteenth grain in the second being the report in one instance.

Oliver states that an American company, the Electrical Storage Battery Company, were using electrolytic baths as a routine method of prevention as early as 1914.

Results of later experiments on the possibility of removing lead from the body by electrolysis

Sir Kenneth Goadby and Mr. W. H. F. Oxley made various experiments on Oliver's contention and both came to the conclusion that the electrolytic baths could not remove lead from the body in any demonstrable quantities.

For account of their experiments and conclusions, see Appendix A (a) and (b) to this chapter.

A further consideration of the efficacy of Oliver's treatment is contained in Appendix A of "Lead Poisoning in the Pottery Trades," by B. J. Newman, W. J. McConnell, O. M. Spencer and F. M. Phillips, 1921. Their conclusion is that as an adjunct to other treatment, the method is of probable value simply for its symptomatic effects. As their investigation of the subject was based on actual results on lead workers, part of their report is reproduced here in Appendix A (c).

APPENDIX A

ELECTROLYTIC TREATMENT OF LEAD POISONING

(a) EXPERIMENTS OF W. H. F. OXLEY.

(The Lancet, October 3, 1914, pp. 848-9.)

In further elucidation of the question as to the possibility of the removal of lead from the body in lead workers by means of electrolysis, as described by Sir Thomas Oliver,¹ I have performed the following series of tests on workmen showing signs of lead absorption and on lead-poisoned rabbits.

Experiment No. 1.—The first step was to apply the treatment to a number of workers in lead smelting, litharge making, and white lead making. Eight men—some with marked blue lines, some with faint blue lines, and others who showed the very earliest trace of blue line—were picked out. A proportion were old hands who showed, besides the blue line, some evidence of lead absorption, such as pallor, anaemia, and tremors, while others were perfectly healthy. All stages in the process of absorption were thus included. The electrical apparatus was set up as described by Sir Thomas Oliver, a voltage of 16 being employed, the positive electrode being placed in the foot-bath and the negative in the hand-bath, and a current of 25 ma. was passed through for 40 minutes (a dosage of 60 coulombs of electricity), and this was increased in the later baths to 35 ma. (84 coulombs). A bath was given on alternate days. Three of the men had 18 baths, 2 had 14, and the remainder 6, 7, and 8 respectively. The result in all cases was absolutely negative. There was no apparent change in the blue line except in the case of one man, who had been scrubbing his gums with a hard brush and had excoriated the mucous membrane. The signs of lead absorption were unaltered. All the men complained of feeling languid after the baths, and one stated that he had lost weight, while two had a little dermatitis on the legs and forearms.

Experiment No. 2.—It was next attempted to confirm Sir Thomas Oliver's statement that lead was found in the bath water and electrodes after use, and the following was the method employed. The electrodes were scrupulously cleaned with HNO_3 , and the water used was ascertained to be free from lead. A man with a marked blue line was taken, and his arms and legs were well scrubbed. He was then placed in the baths for 40 minutes without current, when the water was again ascertained to be free from lead. This was done to avoid the possible error due to lead from the skin contaminating the water. The current was then turned on, and he was given 35 ma. for 40 minutes (84 coulombs), when the electrodes were removed from the water, thus stopping the current, and the water from both arm- and foot-bath was tested separately. No lead was found. Each electrode was then tested as follows: washed in HNO_3 , solution neutralized with KHO , faintly acidulated with HCl , H_2S passed through. No lead present. On addition of Am_2S to solution a heavy black colour appeared, separating as a black precipitate. The precipitate was dissolved in HNO_3 , neutralized with KHO ; on addition of KCNS a deep, blood-red colouration appeared, indicating the presence of iron. A small piece of one of the electrodes was then tested; iron was present. It was thought possible that this iron precipitate might have been confounded with lead if no confirmatory tests had been made.

Experiment No. 3.—Another experiment was made on exactly the same lines as No. 2, except that the aluminum electrodes supplied with the apparatus were exchanged for 6 inch by 6 inch platinum sheets. No trace of lead was found.

Experiment No. 4.—A bath was given to 6 men successively, using the same water in each case. They were all old hands; 1 had had a previous attack of colic; 3 were definitely anaemic, and all had blue lines. Each was given a dose of 84 coulombs. No trace of lead was found either on the electrodes or in the water.

Thinking that it might possibly be contended that, although no lead was found in the baths, the passage of the electric current through the body might have the effect of rendering the lead more easy of elimination by the kidney, the following experiment was performed.

Experiment No. 5.—A 24-hours' specimen of the urine of two old hands was examined for lead; none was present. On the following day a bath of 35 ma. (for 40 minutes) was given to each, and the 24-hours' urine was again collected. No lead was found (the electrolytic method was used). A negative result was also obtained in testing the water and electrodes in this case.

The results up to this having been uniformly negative, it was decided to conduct a series of tests on rabbits and to submit them to a larger dosage of electricity. Two rabbits were taken.

Rabbit No. 1 was given 9 doses of 0.05 grm. of lead nitrate hypodermically and 3 doses of 0.025 grm. It lost weight rapidly and on the twenty-second day developed paralysis, dying on the twenty-fourth day. The organs were examined, and 6.25 mgm. of lead recovered.

Rabbit No. 2 was given five doses of 0.05 grm. lead nitrate and three doses of 0.025 grm. It lost weight rapidly, and on the twenty-third day was given a bath of 30 ma. for 60 minutes, the fur on the legs having been removed. The water and the electrodes were then tested for lead, and none was present, but iron was again found in the washings from both electrodes, and a trace

¹ The Lancet, August 23rd, 1913, p. 527.

of copper in the water, which latter had probably come from the copper worm of the distillation apparatus. On the twenty-sixth day it was given a bath of two hours' duration at 35-40 ma., over four times the dosage employed by Sir Thomas Oliver. No lead was present either in water or electrodes. From the thirty-second day it was fed with 0.05 gm. daily for four days and became extremely weak. It was then given a bath of 36 ma. for four hours. No lead was found in the bath or electrodes. It was then killed, skinned, and the body bathed with a current of 90 ma. for three hours. No lead was found. 30 grms. of the liver were made into emulsion with physiological saline solution and placed in a dialyser floating in distilled water, and a current of 35 ma. passed through for 40 minutes. The water and electrodes were then examined for lead with a negative result. A subsequent chemical analysis of the liver showed it to contain 2.2 mgm. of lead.

Conclusion.—These results would appear to show that the treatment as described by Sir Thomas Oliver has no effect upon the blue line, and does not extract lead from the body. The usual tonic effect of an electric bath was not noted, and I am forced to the conclusion that no practical good would result from the regular treatment of lead workers in this way. The experiments with the rabbit show a consistently negative result even under more favourable conditions for lead extraction than can be obtained in the human subject.

A consideration of the conditions under which we are working will, I think, show that these negative results are only what one would expect. The body may be regarded as a mixture of different salts in solution as electrolytes, of a strength of about 8 per 1,000, added to which there would be a small percentage of some lead compound or compounds, the exact nature of which we do not know, nor do we know whether they are present in the condition of dissociation necessary for them to become electrolysable. However that may be, the amount is very small; taking Legge and Goadby's figure of 0.005 gm. per kg., as the minimal poisoning dose,¹ the proportion of lead ions to tissue ions would not be more than 1 to 1,600. Now it has been found that in a solution of mixed electrolytes all the electrolytes assist in the conduction of the current, and take part in the migration towards the poles, the ratio of concentration of ions not undergoing change.² They are not all deposited on the electrodes, but they are using up the current, thus leaving very little to take part in the electrolysis of the lead. Further, if the proportion of any one electrolyte be very small, it is impossible to extract it without a large increase in the potential.³ Exact figures are impossible to give, but taking the tissue ions as being very largely sodium, a calculation will show that the amount of electricity available for the electrolysis of the lead would not be sufficient to deposit more than 0.04 mgm. of lead per bath, which is quite a negligible amount.

A further difficulty in the extraction of lead from the body by this means appears to have been overlooked. I refer to the extremely slow rate of the penetration of ions through an animal membrane or similar substance. Lodge,⁴ using a tube of gelatin, found the velocity for hydrogen ions to be 10.8 mm. per hour, and for sodium ions 1.26 mm. Sloan⁵ found the penetration of Cu ions through the ox stomach with a current of 5 ma. for five hours to be 3 mm., and in white of egg, with an amount of 100 coulombs, after two hours the penetration was 2.5 mm.

Taking these two factors into consideration: first, the large proportion of total current used up by the tissue ions, and secondly, the slow rate of penetration of the ions through the skin, it would appear that the total possible effect of a bath would be to remove from the superficial layers of the skin an amount of lead not exceeding 1/7500th part of a grain. The conditions are the reverse to those obtaining in ionic medication, where concentrated solutions are used, and the whole of the current is, near the surface at any rate, available for the driving inwards of the drugs used. It is, of course, possible that the effect of the baths may be to increase the elimination of lead by the ordinary channels. Oliver, however, states that after the baths the excretion of lead by the kidneys is diminished, and in the two examinations made by me no lead was found after the baths.

I am much indebted to Dr. A. W. Stewart, of the Royal Institute of Public Health, and to Mr. Cowan, Manager of Messrs. Lock and Lancaster, Bridgeroad, Poplar, for the help given to me in these investigations.⁶

(b) EXPERIMENTS OF KENNETH GOADBY.

(*The Lancet*, October 3, 1914, pp. 846-7.)

In a paper entitled "The Preventive and Curative Treatment of Industrial Lead Poisoning,"⁷ Sir Thomas Oliver discusses at length an electrolytic method of eliminating lead from the body, which he described as a "new, or bipolar bath," the method described being the use of four vessels, one for each foot and one for each hand, the two sets of baths holding the positive and

¹ Lead Poisoning and Lead Absorption.

² Leblanc, *Electro-Chemistry*.

³ Classen, *Chemical Analysis by Electricity*.

⁴ Lewis Jones, *Ionic Medication*.

⁵ *Brit. Med. Jour.*, August 31st, 1912.

⁶ Further references are: Leduc, *Annual Meeting, British Medical Association*, 1907. Lodge, *Conduction of Electricity*, *Brit. Med. Jour.*, Oct. 4th, 1911.

⁷ *The Lancet*, August 23rd, 1913, p. 527.

negative electrodes respectively, as opposed to the method of a "single bath" in which one electrode, anode or cathode, is placed in the bath, the other or indifferent electrode being applied to the skin by means of a pad moistened with salt solution.

In the paper referred to, a claim is made of the efficacy of this method for the treatment of chronic lead poisoning, based upon the supposition that lead "is probably present in the tissues in the form of metallic chloride or other inorganic salt," and that under the influence of the electric current, it would be passed outwards and be deposited electrolytically on the aluminum electrodes. It is stated that under the influence of the electrolytic method, the blue line present in the gums of persons suffering from lead absorption disappeared, and that lead was demonstrable upon the electrodes in the baths. It was therefore thought of interest to inquire experimentally into the behaviour of lead salts in relation to albuminous substances, and the possibility of the experimental removal of lead from the tissues of lead-poisoned animals.

The bath recommended by Sir Thomas Oliver consists of two arm and leg baths, sufficiently deep to allow immersion of the limb to the elbow or to the knee, the anode being placed in the foot bath and the cathode in the arm bath; the electrodes were of aluminum, and a current of 20 to 40 ma. was used at a voltage of 16. The baths were filled with salt solution. The experiments I have conducted were devised to follow, as far as possible, these conditions, but the current employed was varied from 20 to 100 ma. Blank control experiments were undertaken in every instance. Aluminum electrodes were used in the earlier experiments, but after washing the electrode with HNO_3 and passing H_2S for the detection of lead, a black precipitate was obtained of iron sulphide; the aluminum electrodes were therefore abandoned and platinum used. Some trouble was also experienced with both the distilled water and sodium chloride, owing to both containing minute traces of both iron and copper when the ordinary laboratory materials were used; and special care was therefore taken to eliminate this source of error.

Account of experiments.—Six animals were subjected to experiment, four cats and two dogs. Lead nitrate was used, and 0.05 gm. per kg. body weight was inoculated intramuscularly into the muscles of the back and neck. After a variable period, 10 to 20 days, the animals were subjected to electrolysis; the forelegs were immersed to the shoulder in one bath, and the hindlegs in another bath of normal saline; the electrodes, platinum soldered into platinum wire with pure gold, were placed in each bath and a current controlled by a shunt resistance, voltmeter and milliamperemeter passed through. The animals were placed under an anæsthetic during the experiment.

With the first two animals a current of 30 ma. at 20 volts was used. After an hour's passage no deposit of lead was found on either electrode (cathode or anode). Toward the end of the experiment the animal's heart showed signs of great acceleration. This acceleration was much more pronounced when the whole four limbs of the animal were immersed than when only one foreleg and one hind limb of the same side were placed in the bath circuit.

In the third experiment, the current used was increased to 100 ma. The heart beats became accelerated after 10 minutes' application of the current, the heart finally ceasing to beat. The current was stopped and artificial respiration and massage to the chest applied. The heart commenced to act again, but was hypersensitive to 30 ma. of current and finally ceased to beat. The electrolysis was continued for 30 minutes after the animal was dead, with a current of 100 ma. The electrodes were subsequently washed with hot 10 per cent. HNO_3 containing a few drops of alcohol, and the washings investigated for the presence of lead. No black precipitate was obtained with sulphuretted hydrogen, or any evidence of the presence of lead.

A fourth experiment with a cat gave exactly similar results, and no lead was obtained from the electrodes, even after $1\frac{1}{2}$ hours' exposure on four different occasions.

A dog was inoculated with lead nitrate, 0.05 gm. per kg. body weight being used. At the end of three weeks symptoms of lead paralysis were evident, and the animal was submitted to electrolysis. A current of 50 ma. at 20 volts was used, with normal saline baths free from lead and iron, and platinum electrodes of 300 sq. cm. surface; the time of exposure was one hour. Three baths were given, but the animal died from general lead paralysis. No lead was recovered from the electrodes on either of these occasions.

After death the animal's liver was removed and found to weigh 335 gm. A quantity, 162 gm., was removed and triturated in a mortar, normal saline added, and the whole placed in an electrolytic cell with platinum electrodes and a current of 0.14 ampère passed for 12 hours. The electrodes were then removed and tested for lead by washing in distilled water, boiling with 10 per cent. HNO_3 , with a few drops of alcohol. The washings gave no black precipitate on neutralization with KOH and passing H_2S . The substance was then transferred to a large evaporation basin, strong HNO_3 and potassium chlorate added, and the substance digested till all organic matter had disappeared, evaporated to dryness, incinerated, and the residue taken up in 10 per cent. HNO_3 and the fluid returned to the same cell for electrolysis. The conductivity was found much greater than before, and a considerable extra resistance was necessary to reduce the amperage to 0.14, the same reading as in the undigested liver emulsion. The cell was allowed to act for 12 hours. At the end of this time the anode was coated with a black deposit, which was found to be lead; the cathode was free from lead. The quantity estimated volumetrically was found to be 0.0049 gm. for the whole weight of liver.

Lead was therefore present in the liver, probably as an "albuminate"; it was not acted upon or deposited by the electric current until it had been freed from its organic combination, but when this was accomplished and a suitable electrolyte used, a deposit readily took place. A metal absorbed by albumin is undissociated. There was therefore no experimental evidence

to show that lead is ionizable when present in the animal body, either in the incipient or established stage of lead poisoning. The absence of any deposit from the electrolysis of the animal's liver emulsion subsequently shown to contain lead, as well as the much lower conductivity of the solution, points to little dissociation of lead ions in the body; and as without such dissociation no deposit of the metal is likely to take place, this question was submitted to further tests as follows:

A 10 per cent. solution of lead nitrate was added to a 5 per cent. solution of egg albumin, the thick, curdy precipitate was filtered off and washed with distilled water, and dialysed against distilled water for four weeks. Even at the end of this time traces of lead were found in the dialysis water. Suspended in water no black precipitate was obtained with H_2S , but on addition of HCl or KOH a thick black precipitate was obtained. With Millon's reagent the dialysate also gave red precipitate, as well as the biuret reaction with copper sulphate. The substance thus gave the combined reactions of lead and albumin, but still contained some free lead as shown by the washings.

About 10 gm. of the "lead albuminate" was next treated with 25 c.c. normal horse serum and allowed to stand for 12 days, after which the supernatant clear serum was pipetted off and tested electrolytically as follows: A cell was constructed with an inner and outer vessel; in the outer vessel was placed normal sodium chloride. The inner vessel consisted of a dialysis tube of parchment paper and contained the serum which had been in contact with "lead albuminate." Two platinum electrodes, 5 x 10 cm., were placed in the inner and outer vessels, and a current of 0.1 ampère at 8 volts passed, the apparatus being left all night at the room temperature. The electrodes, which were quite bright, were removed at the end of 14 hours, washed gently in distilled water, and subsequently boiled in 10 per cent. HNO_3 , with the addition of a few drops of alcohol, and the fluid tested for lead with negative results.

The serum was then removed from the inner vessel, strong nitric acid and potassium chlorate added, and the fluid boiled and evaporated to a thin syrup, all the organic matter being broken up. 10 per cent. nitric acid was added, and the fluid transferred to the same cell and the current passed as before. In 30 minutes a well-marked black staining of the anode was apparent; this was dissolved off in 10 per cent. nitric acid as before, and gave positive tests for lead. A blank control made with the acid and potassium chlorate gave a negative result.

The serum had therefore taken up a proportion of the "lead albuminate" in an undissociated form which was not acted upon by the electric current under conditions closely resembling those of the animal's limb immersed in a saline bath. There is no support to the contention, therefore, that even if lead be stored upon the peripheral structures it is removable by electrical means. But the major part of lead recoverable from the body of persons dead of lead poisoning is found in the internal organs; thus Wynter Blyth¹ found 0.6 gm. in the liver, 0.003 gm. in the kidney, and 0.072 gm. in the brain. Hougouencq² found 0.258 gm. in the intestines, 0.005 gm. in the liver, and 0.0088 gm. in the brain of a person dead of lead poisoning. Dixon Mann³ found the faeces containing large quantities of lead when administered by the mouth, and points out that the excretion of lead is mainly through the intestines; my own experiments⁴ are in complete accord with this, and in many instances I have obtained considerable quantities of lead from the faeces of animals inoculated subcutaneously with soluble lead compounds, and I have also recovered amounts of lead from 0.001 to 0.008 gm. in the faeces of lead workers who were exposed to lead absorption, but who showed no clinical symptoms of lead poisoning.

In the paper quoted above it is stated that the lead present in the body at any time only amounts to a few grains, and that therefore the quantity eliminable by the electrolytic method is probably too small to determine, but in my experiments, sufficient lead was present to be estimated by electrolysis when free from organic combination (0.0049 gm.); if, therefore, any deplumbizing effect is produced by electrolytic baths, the five experiments quoted would certainly have given some indication of its presence, but in every case a negative result was obtained. Ionic medication with iodine or salicylate is not comparable with the hypothetical removal of lead by ionic means, as in the application of drugs the electrolytes chosen are always dissociated, and their efficiency and penetrability depend upon their dissociation, while there is every reason to suppose that lead as an organic absorption compound is not dissociated, as shown by the liver emulsion experiment. Lead chloride or any soluble salt of lead in the presence of albumin forms a thick, curdy, white precipitate, as does solution of albumose or peptone; any lead, therefore, circulating in the blood is unlikely to remain as a simple organic salt, but unless it does so—and there is no evidence to show that it does, and much to show that it does not—it will not undergo ionization by small electric currents. Iron is easily deposited by electrolysis; if, therefore, Sir Thomas Oliver's contention is correct that lead is eliminated electrolytically by a double bath or any other method, the iron from the hæmoglobin of the red blood corpuscles should also be removed. Small quantities of lead no doubt have been found in the vessels in which lead workers' arms and legs were treated, as it is notoriously difficult to remove the last traces of lead from the hands of persons engaged in manipulating lead compounds, the fine dust penetrating the external layers of the epidermis and even filtering through the clothes. The hands and arms of a lead worker, after careful scrubbing with soap and hot water, may easily be shown to contain traces of lead.

1 Proceedings of Chemical Society, 1887-88.

2 Meillere: *Le Saturnisme*, p. 73.

3 Brit. Med. Jour., 1893.

4 Legge and Goadby, *Lead Absorption and Lead Poisoning*, 1912.

The experiments *in vivo* and *in vitro* give no support to the contention that lead is eliminated from the animal body by the electrolytical methods tested, neither do they suggest any grounds for the adoption of electrolytic baths for the prevention or treatment of lead absorption or lead poisoning.

(c) CONTRIBUTION TO THE SUBJECT CONTAINED IN "LEAD POISONING IN THE POTTERY TRADES," BY B. J. NEWMAN, W. J. MCCONNELL, O. M. SPENCER AND F. M. PHILLIPS, U.S.P.H.S., P. H. BULL. No. 116, MAY, 1921, APPENDIX A, PP. 188-190.

"Oxley's and Goadby's findings support each other, and their conclusions agree; but they fail to confirm Oliver's findings in any particular.

"As a further test of the efficiency of the treatment, Dr. A. D. McCracken, in a recent communication to this office, proposes the following experiment: 'Determine the amount of lead in the urine for three successive days without treatment, then for three days under intensive electrical treatment, and for the three days following. This will not include the lead excreted by the bowel, and as we know that free purgation does relieve the condition, it may be that much the larger part of the lead is eliminated by the bowel, and possibly the experiment should include the bowel discharges also. I suppose that the same method for finding the lead in the urine would be applicable to the faeces.'

"However, present day opinion among physicians is practically worthless. Careful records have not been kept, and opinions are based largely on statements made by patients rather than on observation of patients for a long period of time. The differences in the opinions offered render them of little value.

"Sir Thomas Oliver maintains that persons suffering from lead poisoning show few, if any, signs of plumbism after two or three weeks' treatment with the electrolytic process, while a bath once or twice a week prevents lead from settling in the system; and that rheumatic joints, so-called, improve, and double wrist-drop slowly disappears.

"While Dr. McCracken, of the Wardner Hospital, believes that there is a rapid clinical improvement with the treatment, Schmitter treated 12 patients without benefit; but he does not state whether the condition of the patient was such that structural alterations of the tissues had advanced too far.

"Botterick, while he admits that lead is found in the water of the bath after electrical treatment, thinks that this lead comes possibly from the skin, for lead compounds are known to enter into such close combination with the skin that weeks after men have left off work, and after repeated careful cleansing of the skin, lead can still be detected in the water of the bath.

"In attempting to find data in addition to that secured from a physical examination of workers in exposed processes, in order to make a definite statement as to the amount of sickness and death occurring from lead among the pottery workers of New Jersey, Acting Assistant Surgeon Eloise Meek states, after a visit to the hospital to inspect the Clague-Oliver machine which the Brotherhood of Operative Potters had placed there:

"It was operated by a nurse in charge; a motor-generator set, 110 volts, connected through a rheostat registering 0.01-0.3, was connected to a positive and negative carbon plate 9 by 4, each of which was placed in a separate fibre tub half filled with a warm solution, to act as an electrolyte. The patient places the affected member, or part, in one of the tubs, and another extremity is put into the alternate tub. The current is then applied, and a gradually increasing current density is used for three-quarters of an hour. Treatments are supposed to be given twice a week, continuing for a minimum of six weeks.

"The nurse stated that most of the cases improved, although, when permission was asked to see records, it was explained that as the patients were sent by the union no records or names were kept, treatments being free and patients coming voluntarily. Her report had merely listed 22 cases as treated, but did not indicate whether all were pottery workers. One case, the most pernicious, was not a pottery worker.'

"A more recent visit to the Mercer Hospital revealed the fact that the pottery workers were taking fewer treatments, with longer intervals between treatments, although they maintained that they derived some benefits from the treatments.

"A survey made by Assistant Surgeon Marvin D. Shie, of the East Liverpool City Hospital, indicates that 36 pottery workers received treatment during a period of five months, with a total of 316 treatments. It is interesting to note that only one man took the treatment for the prescribed length of time. He had wrist-drop when he began the treatment, and wrist-drop when he finished. He was somewhat improved, however, but his improvement may well have been due to his absence from work for part of that time. The person who took the next highest number, 35, is dead. She died of lead poisoning. The other people who have taken the treatment show no physical improvement; in fact, with some of them the intoxication has slowly progressed in spite of the treatments, although some of their symptoms may be alleviated. While the opinion of many of the potters themselves is that the treatment is of some value, this belief does not seem to have been strong enough to cause them to take it with any regularity. This lack of regularity, shown by the fact that only 316 treatments were taken when 1,500 to 2,000 should have been taken, lessens the value of any conclusion which might be drawn as to the results.

The statistics given at East Liverpool Hospital are as follows:

October 1, 1918—February 25, 1919.

Number of persons treated.....	36 (1 female).
Total number of treatments given.....	316 (30 minutes each).
Average number of treatments per case.....	8.8; per month, 1.8.
Minimum number treatments per case.....	1 per month.
Maximum number of treatments per case.....	43; per month, 8.6.
Occupations of persons treated.....	24 dippers, 1 kiln hand, 1 presser 10 not stated.
Average age of 24 persons treated.....	46.1 years.
Average length of time (24 persons) in occupation..	27.5 years.

"The men who had taken the treatment were questioned as to their effects. Most of them made favourable statements, the substance of which is as follows:

1. The patients always feel better immediately after the treatment. This sense of increased well-being often lasts for several days.
2. Appetite is increased.
3. Insomnia is diminished. Sleep is promoted.
4. Those who have wrist-drop and weakness of the muscles of the forearm state that their muscles are stronger immediately after the treatment, and that they are able to grasp things better.
5. Headaches are decreased and diminished in severity.
6. Usually some slight gain in weight is made, probably because of increased appetite and better sleep.

"The benefit thus experienced is of no little value, even though it is almost entirely symptomatic. It means much to men who have been suffering from insomnia, headaches, and local and general asthenia to get even temporary relief when they have taken a 'treatment.' They fallaciously reason from the relief to the elimination of the cause, notwithstanding the fact that in the diagnosis of the examiner plumbism has not decreased, but rather has slowly progressed in some cases. Not enough pottery workers have used the treatment with sufficient regularity to make an evaluation of its worth as a preventive measure possible. One definite result, though, follows the use of the treatment. It does tend to encourage pottery workers to exercise more care in personal hygiene, cleanliness of hands and person, the use of laxatives when they are needed, the keeping of better hours, and like practices, which in themselves help toward prevention and cure. As an adjunct to other treatment, the method is of probable value simply for its symptomatic effects."

Part II

LEGISLATION

CHAPTER I

GREAT BRITAIN

In England the policy is to enact legislation applying to the different lead trades individually. The earliest law relates to the manufacture of white lead and was passed in 1891; since that date the other chief lead trades have been covered. In general, the legislation enforces so many restrictions and precautions on lead plants that it constitutes a strong tacit argument to employers on the advisability of limiting the use of lead wherever possible. It may be added that only a very extensive and highly organized system of factory inspection could hope to ensure compliance with the exceedingly detailed and definite regulations laid down. The general principles of industrial health legislation in England are fundamentally different from those prevailing in U.S.A.; in the former country legislation is coercive and prosecutions for non-compliance frequent; in the latter, legislation may be termed as "suggestive" since it deals largely with general principles and broad rules, far more scope being left to individual employers to work out the technical details for themselves.

The present state of English legislative control of lead trades may be dealt with under the following heads:

- (1) General legislation referring to lead.
- (2) Requirement for reporting of occupational diseases including lead poisoning.
- (3) Compensation for occupational diseases, including lead.
- (4) Legislation relating to lead trades individually.

(1) General legislation referring to lead

(a) **Great Britain, Factory and Workshop Act, 1901** **Portions which bear on lead poisoning**

Part I (*i*) 1, (1)*d* (page 1).—"It" (*i.e.*, every factory as defined by this Act) "must be ventilated in such a manner as to render harmless, so far as is practicable, all the gases, vapours, dust, or other impurities generated in the course of the manufacturing process or handicraft carried on therein, that may be injurious to health."

Part IV (*i*) 73, (1) (pages 41, 42, 43, 44). "Every medical practitioner attending on or called in to visit a patient whom he believes to be suffering from lead, phosphorus, arsenical or mercurial poisoning, or anthrax, contracted in any factory or workshop, shall (unless the notice required by this subsection has been previously sent) send to the Chief Inspector of Factories at the Home Office, London, a notice stating the name and full postal address of the patient and the disease from which, in the opinion of the medical practitioner, the patient is suffering, and shall be entitled in respect of every notice sent in pursuance of this section to a fee of two shillings and sixpence, to be paid as part of the expenses incurred by the Secretary of State in the execution of this Act."

(3) 'Written notice of every case of lead, phosphorus, or arsenical or mercurial poisoning, or anthrax, occurring in a factory or workshop, shall forth-

with be sent to the inspector and to the certifying surgeon for the district; and the provisions of this Act with respect to accidents shall apply to any such case in like manner as to any such accident as is mentioned in those provisions."

74. "If in a factory or workshop where grinding, glazing, or polishing on a wheel, or any process is carried on by which dust, or any gas, vapour, or other impurity, is generated and inhaled by the workers to any injurious extent, it appears to an inspector that such inhalation could be to a great extent prevented by the use of a fan or other mechanical means, the inspector may direct that a fan or other mechanical means of a proper construction for preventing such inhalation be provided within a reasonable time; and if the same is not provided, maintained, and used, the factory or workshop shall be deemed not to be kept in conformity with this Act."

75. (1) "In every factory or workshop where lead, arsenic, or any other poisonous substance is used, suitable washing conveniences must be provided for the use of the persons employed in any department where such substances are used.

"(2) In any factory or workshop where lead, arsenic, or other poisonous substance is so used as to give rise to dust or fumes, a person shall not be allowed to take a meal, or to remain during the times allowed to him for meals, in any room in which any such substance is used, and suitable provision shall be made for enabling the persons employed in such rooms to take their meals elsewhere in the factory or workshop."

77. (1) (b) "In the part of a factory or workshop in which there is carried on . . . the process of making white lead, a young person or child must not be employed."

(4) "In the part of a factory or workshop in which there is carried on (a) any dry grinding in the metal trade . . . a child must not be employed."

78. (1) (page 43) "A woman, young person, or child must not be allowed to take a meal or to remain during the times allowed for meals in the following factories or workshops, or parts of factories or workshops, that is to say . . . (d) in the case of earthenware works, in any part known or used as dippers, house dippers, drying room, or china scouring room."

(b) Women and Young Persons' (Employment in Lead Processes) Act, 1920.

An Act to make provision for the Better Protection of Women and Young Persons against Lead Poisoning (10 and 11 Geo. 5, ch. 62). Dated 23rd December, 1920.

Whereas at Washington, on the twenty-eighth day of November, nineteen hundred and nineteen, a general conference of the International Labour Organization of the League of Nations adopted a Recommendation in the form set out in the Schedule to this Act, and it is expedient that, for the purpose of carrying out the said Recommendation, the provisions hereinafter contained should have effect:

Be it therefore enacted by the King's most excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same, as follows:

1. It shall not be lawful for any person to employ any woman or young person in any of the following operations:

- (a) Work at a furnace where the reduction or treatment of zinc or lead ores is carried on;
- (b) The manipulation, treatment, or reduction of ashes containing lead, the desilverizing of lead, or the melting of scrap lead or zinc;
- (c) The manufacture of solder or alloys containing more than ten per cent. of lead;
- (d) The manufacture of any oxide, carbonate, sulphate, chromate, acetate, nitrate, or silicate of lead;
- (e) Mixing or pasting in connection with the manufacture or repair of electric accumulators;
- (f) The cleaning of workrooms where any of the processes aforesaid are carried on.

2.—(1) It shall not be lawful for any person to employ in any process involving the use of lead compounds any woman or young person if the process is such that dust or fume from a lead compound is produced therein, or the persons employed therein are liable to be splashed with any lead compound in the course of their employment, unless the following regulations are complied with as respects all women and young persons employed:

- (a) Where dust or fume from a lead compound is produced in the process, provision must be made for drawing the fume or dust away from the persons employed by means of an efficient exhaust draught so contrived as to operate on the dust or fume as nearly as may be at its point of origin;
- (b) The persons employed must undergo the prescribed medical examination at the prescribed intervals, and the prescribed record must be kept with respect to their health;
- (c) No food, drink, or tobacco, shall be brought into or consumed in any room in which the process is carried on, and no person shall be allowed to remain in any such room during meal times;
- (d) Adequate protective clothing in a clean condition shall be provided by the employer and worn by the persons employed;
- (e) Such suitable cloak-room, mess-room and washing accommodation as may be prescribed shall be provided for the use of the persons employed;
- (f) The rooms in which the persons are employed, and all tools and apparatus used by them, shall be kept in a clean condition.

(2) It shall not be lawful for any person to employ in any process involving the use of lead compounds any woman or young person who has been suspended after medical examination from employment in any such process on the ground that continuance therein would involve special danger to health.

3.—(1) Where an inspector under the Factory and Workshop Act, 1901, suspects that any substance used or intended for use in any process in which women or young persons are employed contains a lead compound, he may at any time take for analysis sufficient samples of that substance.

(2) If the occupier of the factory or workshop in which any such process is carried on refuses to allow an inspector to take samples in pursuance of this section, or to give him facilities for the purpose, he shall be guilty of obstructing the inspector in the execution of his duties under the said Act.

Provided that the occupier of a factory may, at the time when a sample is taken under this section, and on providing the necessary appliances, require the inspector to divide the sample into two parts and to mark and seal and deliver to him one such part.

(3) In this section the expression "occupier of a factory or workshop" includes any person employing a woman or young person in any process involving the use of lead compounds in any place other than a factory or workshop.

(4) A certificate purporting to be a certificate by the Principal Chemist of the Government Laboratory as to the result of an analysis of a sample under this section shall, in any proceedings under this Act, be evidence of the matters stated therein, unless either party requires the person by whom the analysis was made to be called as a witness.

(5) It shall not be lawful for any person, except in so far as is necessary for the purposes of a prosecution for an offence under this Act, to publish or disclose to any person the results of an analysis made under this Act.

If any person acts in contravention of the provisions of this subsection, he shall be liable on summary conviction to a fine not exceeding fifty pounds.

4. Section 73 of The Factory and Workshop Act, 1901, (which requires notification to be sent to the Chief Inspector of Factories of lead poisoning contracted in any factory or workshop), shall apply to lead poisoning contracted by any woman or young person in processes involving the use of lead compounds, whether carried on in factories or workshops or not.

5. If any person employs a woman or young person in contravention of this Act in any place other than a factory or workshop, he shall be liable on summary conviction to a fine not exceeding twenty pounds, and an inspector appointed under The Factory and Workshop Acts, 1901 to 1911, shall, in relation to the case, have the same powers and duties as if the place in which the woman or young person is employed were a factory or workshop.

6. In this Act,

The expression "young person" means a person who is under the age of eighteen years;

The expression "prescribed" means prescribed by order made by the Secretary of State, and the provisions of paragraph (a) of subsection (3) and subsections (4), (6) and (7) of section 7 of The Police, Factories, etc. (Miscellaneous Provisions) Act, 1916, shall apply with respect to orders made under that section;

The expression "lead compound" means any soluble compound of lead which is declared by order of the Secretary of State to be a lead compound for the purposes of this Act, and includes a mixture containing any such compound, but does not include an alloy containing lead;

The method of ascertaining whether any compound or mixture is a lead compound within the meaning of this Act shall be such as the Secretary of State may prescribe.

7.—(1) This Act may be cited as The Women and Young Persons (Employment in Lead Processes) Act, 1920, and shall be construed as one with The Factory and Workshop Acts, 1901 to 1911, and this Act and those Acts may be cited together as The Factory and Workshop Acts, 1901 to 1920.

(2) This Act shall come into operation on the first day of January, nineteen hundred and twenty-one.

Schedule.

(Text of Recommendation concerning the Protection of Women and Children Against Lead Poisoning.)

The General Conference recommends to the members of the International Labour Organization that, in view of the danger involved to the function of maternity and to the physical development of children, women and young persons under the age of eighteen years be excluded from employment in the following processes:

- (a) In furnace work in the reduction of zinc or lead ores.
- (b) In the manipulation, treatment, or reduction of ashes containing lead, and in the desilverizing of lead.
- (c) In melting lead or old zinc on a large scale.
- (d) In the manufacture of solder or alloys containing more than ten per cent. of lead.
- (e) In the manufacture of litharge, massicot, red lead, white lead, orange lead, or sulphate, chromate, or silicate (frit) of lead.
- (f) In mixing and pasting in the manufacture or repair of electric accumulators.
- (g) In the cleaning of workrooms where the above processes are carried on.

It is further recommended that the employment of women and young persons under the age of eighteen years in processes involving the use of lead compounds be permitted only subject to the following conditions:

- (a) Locally applied exhaust ventilation, so as to remove dust and fumes at the point of origin.
- (b) Cleanliness of tools and workrooms.
- (c) Notification to Government authorities of all cases of lead poisoning, and compensation therefor.
- (d) Periodic medical examination of the persons employed in such processes.
- (e) Provision of sufficient and suitable cloakroom, washing, and mess-room accommodation, and of special protective clothing.
- (f) Prohibition of bringing food or drink into workrooms.

Supplementary Orders:

Meaning of the expression, "lead compound."

Order, dated November 8, 1921, made by the Secretary of State under Section 6 of The Women and Young Persons (Employment in Lead Processes) Act, 1920, (10 and 11 Geo. 5, c. 62), as to the meaning of the expression "lead compound,"¹ and the method of ascertaining whether any compound is a "lead compound" for the purposes of the Act.

In pursuance of Section 6 of The Women and Young Persons (Employment in Lead Processes) Act, 1920, I hereby order that for the purposes of the said Act the expression "lead compound"¹ shall mean any compound of lead other than galena which, when treated in the manner prescribed below, yields to an aqueous solution of hydrochloric acid, a quantity of a soluble lead compound exceeding, when calculated as lead monoxide, five per cent. of the dry weight of the portion taken for analysis.

The method of treatment shall be as follows:

A weighed quantity of the material which has been dried at 100° C. and thoroughly mixed is to be continuously shaken for one hour, at the common temperature, with 1,000 times its weight of an aqueous solution of hydrochloric acid containing 0.25 per cent. by weight of hydrogen chloride. This solution is thereafter to be allowed to stand for one hour and then filtered. The lead salt contained in the clear filtrate is then to be precipitated as lead sulphide and weighed as lead sulphate.

E. SHORTT,
*One of His Majesty's Principal
Secretaries of State.*

Whitehall, 8th November, 1921.

¹ Under the provisions of section 6 of the Act the expression "lead compound" will also include any mixture containing any such compound (as defined in the above Order) but does not include an alloy containing lead.

Medical Examination:

In pursuance of Section 2 (1) (b) of The Women and Young Persons (Employment in Lead Processes) Act, 1920, I hereby make the following Order with respect to the employment of women and young persons in any process involving the use of a lead compound to which the said Section applies,¹ hereinafter referred to as a lead process.

1. All women and young persons employed in a lead process and not subject to periodic medical examinations under any Regulations in force under The Factory and Workshop Act, shall be examined by the Certifying Surgeon for the district appointed under The Factory and Workshop Act, 1901,² once in every three months, on a date of which due notice shall be given.

2. Every such woman and young person shall be supplied by the employer with a health register in the approved form in which the Certifying Surgeon shall enter the dates and results of his examinations and particulars of any directions given by him.

Where the process is carried on in a factory or workshop, such register shall be kept by the occupier but shall be open to the inspection of the worker concerned and shall be handed to the worker on the termination of the employment. Where the process is carried on elsewhere, the register shall be kept by the worker, and shall be produced when required by the employer or by the Surgeon for the purpose of carrying out his duties under this Order.

Cloakroom, Messroom and Washing Accommodation:

In pursuance of Section 2 (1) (e) of The Women and Young Persons (Employment in Lead Processes) Act, 1920, I hereby make the following Order to apply to all factories and workshops or parts of factories or workshops in which women or young persons are employed in any process to which the said Section applies³ hereinafter referred to as a lead process.

1. The occupier shall provide and maintain for the use of all women and young persons employed in a lead process, suitable accommodation for clothing put off during working hours.

The accommodation so provided shall be placed under the charge of a responsible person, and shall be kept clean.

2. The occupier shall provide and maintain for the use of all women and young persons employed in a lead process and remaining on the premises during meal intervals suitable and adequate arrangements for taking their meals. The arrangements shall consist of the use of a room separate from any workroom, which shall be furnished with sufficient tables and chairs or benches with back rests, and unless a canteen serving hot meals is provided, adequate means of warming food and boiling water. The room shall be sufficiently warmed for use during meal intervals, shall be placed under the charge of a responsible person, and shall be kept clean.

(2) Requirements for reporting of occupational diseases, including lead

As already seen, the Great Britain Factory and Workshop Act, 1901, requires "every medical practitioner attending on or called in to visit a patient whom he believes to be suffering from lead . . . poisoning . . . contracted in any factory or workshop," to report the same to the Chief Inspector of Factories. Contrary to the general practice in U.S.A., where, with the exception of California and Connecticut, no state makes any payment to physicians for this service, a fee of two shillings and six pence is paid for each notice.

(3) Compensation for occupational diseases, including lead poisoning

The Workmen's Compensation Act, 1906, provided for compensation for industrial diseases as scheduled. The provisions of the law are as follows:

The Workmen's Compensation Act, 1906⁴**8.—(1) Where**

- (i) the certifying surgeon appointed under The Factory and Workshop Act, 1901, for the district in which a workman is employed certifies that the workman is suffering from a disease mentioned in the Third Schedule to this Act, and is

¹ The processes to which Section 2 of the Act applies are those in which dust or fume from a lead compound is produced, or the persons employed are liable to be splashed with any lead compound. The expression "lead compound" means any soluble compound of lead which is declared by order of the Secretary of State under Section 6 of the Act to be a lead compound for the purposes of the Act, and includes a mixture containing any such compound, but does not include an alloy containing lead. See the Secretary of State's Order dated November 8, 1921. (S. R. & O., 1921, No. 1713.)

² 1 E. 7, c. 22.

³ The processes to which Section 2 of the Act applies are those in which dust or fume from a lead compound is produced, or the persons employed are liable to be splashed with any lead compound. The expression "lead compound" means any soluble compound of lead which is declared by order of the Secretary of State under Section 6 of the Act to be a lead compound for the purposes of the Act, and includes a mixture containing any such compound, but does not include an alloy containing lead. See the Secretary of State's Order dated November 8, 1921. (S. R. & O., 1921, No. 1713.)

⁴ 6 Ed. 7. Ch. 58, pp. 9-12 and p. 28.

thereby disabled from earning full wages at the work at which he was employed; or

- (ii) a workman is, in pursuance of any special rules or regulations made under The Factory and Workshop Act, 1901, suspended from his usual employment on account of having contracted any such disease; or
- (iii) the death of a workman is caused by any such disease;

and the disease is due to the nature of any employment in which the workman was employed at any time within the twelve months previous to the date of the disablement or suspension, whether under one or more employers, he or his dependents shall be entitled to compensation under this Act, as if the disease or such suspension as aforesaid were a personal injury by accident arising out of and in the course of that employment, subject to the following modifications:

- (a) The disablement or suspension shall be treated as the happening of the accident;
- (b) If it is proved that the workman has at the time of entering the employment wilfully and falsely represented himself in writing as not having previously suffered from the disease, compensation shall not be payable;
- (c) The compensation shall be recoverable from the employer who last employed the workman during the said twelve months in the employment to the nature of which the disease was due;

Provided that:

- (i) the workman or his dependents if so required shall furnish that employer with such information as to the names and addresses of all the other employers who employed him in the employment during the said twelve months as he or they may possess, and, if such information is not furnished, or is not sufficient to enable that employer to take proceedings under the next following proviso, that employer upon proving that the disease was not contracted whilst the workman was in his employment shall not be liable to pay compensation; and
- (ii) if that employer alleges that the disease was in fact contracted whilst the workman was in the employment of some other employer, and not whilst in his employment, he may join such other employer as a party to the arbitration, and if the allegation is proved that other employer shall be the employer from whom the compensation is to be recoverable; and
- (iii) if the disease is of such a nature as to be contracted by a gradual process, any other employers who during the said twelve months employed the workman in the employment to the nature of which the disease was due shall be liable to make to the employer from whom compensation is recoverable such contributions as, in default of agreement, may be determined in the arbitration under this Act for settling the amount of the compensation;
- (d) The amount of the compensation shall be calculated with reference to the earnings of the workman under the employer from whom the compensation is recoverable;
- (e) The employer to whom notice of the death, disablement, or suspension is to be given shall be the employer who last employed the workman during the said twelve months in the employment to the nature of which the disease was due, and the notice may be given notwithstanding that the workman has voluntarily left his employment;
- (f) If an employer or a workman is aggrieved by the action of a certifying or other surgeon in giving or refusing to give a certificate of disablement or in suspending or refusing to suspend a workman for the purposes of this section, the matter shall in accordance with regulations made by the Secretary of State be referred to a medical referee, whose decision shall be final.

(2) If the workman at or immediately before the date of the disablement or suspension was employed in any process mentioned in the second column of the Third Schedule to this Act, and the disease contracted is the disease in the first column of that Schedule set opposite the description of the process, the disease, except where the certifying surgeon certifies that in his opinion the disease was not due to the nature of the employment, shall be deemed to have been due to the nature of that employment unless the employer proves the contrary.

(3) The Secretary of State may make rules regulating the duties and fees of certifying and other surgeons (including dentists) under this section.

(4) For the purposes of this section the date of disablement shall be such date as the certifying surgeon certifies as the date on which the disablement commenced, or, if he is unable to certify such a date, the date on which the certificate is given:

Provided that:

- (a) Where the medical referee allows an appeal against a refusal by a certifying surgeon to give a certificate of disablement, the date of disablement shall be such date as the medical referee may determine;
- (b) Where a workman dies without having obtained a certificate of disablement, or is at the time of death not in receipt of a weekly payment on account of disablement, it shall be the date of death.

(5) In such cases, and subject to such conditions as the Secretary of State may direct, a medical practitioner appointed by the Secretary of State for the purpose shall have the powers and duties of a certifying surgeon under this section, and this section shall be construed accordingly.

(6) The Secretary of State may make orders for extending the provisions of this section to other diseases and other processes, and to injuries due to the nature of any employment specified in the order not being injuries by accident, either without modification or subject to such modifications as may be contained in the order.

(7) Where, after inquiry held on the application of any employers or workmen engaged in any industry to which this section applies, it appears that a mutual trade insurance company or society for insuring against the risks under this section has been established for the industry, and that a majority of the employers engaged in that industry are insured against such risks in the company or society and that the company or society consents, the Secretary of State may, by Provisional Order, require all employers in that industry to insure in the company or society upon such terms and under such conditions and subject to such exceptions as may be set forth in the Order. Where such a company or society has been established, but is confined to employers in any particular locality or of any particular class, the Secretary of State may for the purposes of this provision treat the industry as carried on by employers in that locality or of that class, as a separate industry.

(8) A Provisional Order made under this section shall be of no force whatever unless and until it is confirmed by Parliament, and if, while the Bill confirming any such Order is pending in either House of Parliament, a petition is presented against the Order, the Bill may be referred to a Select Committee, and the petitioner shall be allowed to appear and oppose as in the case of Private Bills, and any Act confirming any Provisional Order under this section may be repealed, altered, or amended by a Provisional Order made and confirmed in like manner.

(9) Any expenses incurred by the Secretary of State in respect of any such Order, Provisional Order, or confirming Bill shall be defrayed out of moneys provided by Parliament.

(10) Nothing in this section shall affect the rights of a workman to recover compensation in respect of a disease to which this section does not apply, if the disease is a personal injury by accident within the meaning of this Act.

THIRD SCHEDULE.

A.D. 1906.

Section 8.

Description of disease	Description of process
Anthrax.....	Handling of wool, hair, bristles, hides and skins.
*Lead poisoning or its sequelæ.....	Any process involving the use of lead or its preparations or compounds.
Mercury poisoning or its sequelæ.....	Any process involving the use of mercury or its preparations or compounds.
Phosphorus poisoning or its sequelæ....	Any process involving the use of phosphorus or its preparations or compounds.
Arsenic poisoning or its sequelæ.....	Any process involving the use of arsenic or its preparations or compounds.
Ankylostomiasis.....	Mining.

Where regulations or special rules made under any Act of Parliament for the protection of persons employed in any industry against the risk of contracting lead poisoning require some or all of the persons employed in certain processes specified in the regulations or special rules to be periodically examined by a certifying or other surgeon, then, in the application of this schedule to that industry, the expression "process" shall, unless the Secretary of State otherwise directs, include only the processes so specified.

(4) Legislation relating to lead trades individually

(a) The trades covered

(1) Manufacture of white lead, 1891.

(2) Manufacture of electric accumulators (storage batteries), 1903.

(3) File-cutting by hand, 1903.

*Slightly modified February 26, 1918, to include lead poisoning or its sequelæ incurred in the handling of lead, its preparations or compounds.

- (4) Manufacture of paints and colours, 1907.
- (5) Heading of yarn dyed by means of lead, 1907.
- (6) Vitreous enamelling of metal or glass, 1908.
- (7) Tinning of metal hollow-ware, 1909.
- (8) Smelting of lead, manufacture of red or orange lead, manufacture of flaked litharge, 1911.
- (9) Manufacture and decoration of pottery, 1913.
- (10) Manufacture of certain compounds of lead (carbonate, sulphate, nitrate, or acetate), 1921.

(b) Brief indication of points covered

The following points are common, with varying emphasis, to most of the laws:

(1) *Fume and dust elimination.* Chief emphasis is placed on this method of health protection; regulations deal both with devices for preventing the creation of fumes and dust, and artificial means of carrying off fumes and dust.

(2) *Regulation of employment.* This covers both prohibition of employment of women and children in certain processes, and restrictions on continuous employment of all workers at the most hazardous jobs.

(3) *Cleanliness.* This covers provision of overalls and lockers, washing facilities of all sorts.

(4) *Medical examination and the keeping of health registers.*

- (a) Health Registers. To contain a list of all persons employed in lead processes, with dates and results of the physicians' examinations, etc., are to be kept and must be produced on request in the following trades:

White lead, manufacture of.

Compounds of lead, manufacture of.

Pottery, manufacture and decoration of.

Lead smelting and manufacture of red lead, orange lead and flaked litharge.

Paints and colours, manufacture of.

Electric accumulators, manufacture of.

Tinning of metal hollow-ware.

Vitreous enamelling of metal and glass.

Heading of yarn, dyed with lead.

(b) Periodical medical examination.

Weekly ("or at such other intervals as may be approved by the Surgeon") for workers in lead processes in the manufacture of compounds of lead.

Monthly for workers in lead processes in:

The manufacture of electric accumulators.

Manufacture of paints and colours.

Lead smelting and manufacture of red lead, orange lead, flaked litharge.

Certain kinds of employment in manufacture and decoration of pottery.

Quarterly for workers in lead processes in:

Tinning of metal hollow-ware.

Vitreous enamelling of metal and glass.

Heading of yarn, dyed with lead.

(c) Initial medical examination.

This is required "within seven days" for certain specified processes in the pottery trade where certificates of permission to work are obligatory.

(5) *Prohibition of eating in workrooms and provision of dining rooms.*

(6) *Respirators.*

These are required in some processes of some trades only.

(c) Text of the lead laws

(1) Manufacture of White Lead¹

Code of Special Rules established under The Factory and Workshop Acts, 1891 and 1895

In these Rules "person employed in a lead process" means a person who is employed in any work or process involving exposure to white lead, or to lead or lead compounds used in its manufacture, or who is admitted to any room or part of the factory where such process is carried on.

Any approval given by the Chief Inspector of Factories in pursuance of Rules 2, 4, 6, 9 or 12, shall be given in writing, and may at any time be revoked by notice in writing signed by him.

Duties of occupiers.

1. On and after July 1st, 1899, no part of a white lead factory shall be constructed, structurally altered, or newly used, for any process in which white lead is manufactured or prepared for sale, unless the plans have previously been submitted to and approved of in writing by the Chief Inspector of Factories.

2.—(a) Every stack shall be provided with a standpipe and movable hose, and an adequate supply of water distributed by a rose.

(b) Every white bed shall, on the removal of the covering boards, be effectually damped by the means mentioned above.

Where it is shown to the satisfaction of the Chief Inspector of Factories that there is no available public water service in the district, it shall be a sufficient compliance with this Rule if each white bed is, on the removal of the covering boards, effectually damped by means of a watering can.

3. Where white lead is made by the chamber process, the chamber shall be kept moist while the process is in operation, and the corrosions shall be effectually moistened before the chamber is emptied.

4.—(a) Corrosions shall not be carried except in trays of impervious material.

(b) No person shall be allowed to carry on his head or shoulder a tray of corrosions which has been allowed to rest directly upon the corrosions, or upon any surface where there is white lead.

(c)* All corrosions before being put into the rollers or washbecks, shall be effectually damped, either by dipping the tray containing them in a trough of water or by some other method approved by the Chief Inspector of Factories.

5. The flooring around the rollers shall either be of smooth cement or be covered with sheet lead, and shall be kept constantly moist.

6. On and after January 1st, 1901, except as hereinafter provided:

(a) Every stove shall have a window, or windows, with a total area of not less than 8 square feet, made to open, and so placed as to admit of effectual through ventilation.

(b) In no stove shall bowls be placed on a rack which is more than 10 feet from the floor.

(c) Each bowl shall rest upon the rack and not upon another bowl.

(d) No stove shall be entered for the purpose of drawing until the temperature at a height of 5 feet from the floor has fallen either to 70° F., or to a point not more than 10° F. above the temperature of the air outside.

(e) In drawing any stove or part of a stove there shall not be more than one stage or standing place above the level of the floor.

Provided that if the Chief Inspector approves of any other means of ventilating a stove, as allowing of effectual through ventilation, such means may be adopted, notwithstanding paragraph (a) of this Rule; and if he approves of any other method of setting and drawing the stoves, as effectually preventing white lead from falling upon any worker, such method may be followed, notwithstanding paragraphs (b) and (e) of this Rule.

¹ Factory and Workshop Orders. 1919 edition, pp. 236-239.

*The following addition to Rule 4 (c) is in force in one works:—

"Provided that the damping of the corrosions shall not be required if efficient exhaust ventilation is applied at the washbecks in such manner as to prevent the inhalation of dust by the workers when putting the corrosions into the washbecks or rollers."

7. No person shall be employed in drawing Dutch stoves on more than two days in any week.

8. No dry white lead shall be deposited in any place that is not provided either with a cover or with a fan effectually removing the dust from the worker.

9. On and after January 1st, 1900, the packing of dry white lead shall be done only under conditions which secure the effectual removal of dust, either by exhaust fans or by other efficient means approved in each case by the Chief Inspector of Factories.

This Rule shall not apply where the packing is effected by mechanical means entirely closed in.

10. The floor of any place where packing of dry white lead is carried on shall be of cement, or of stone set in cement.

11. No woman shall be employed or allowed in the white beds, rollers, washbecks or stoves, or in any place where dry white lead is packed, or in other work exposing her to white lead dust.

12.—(a) A duly qualified medical practitioner (in these Rules referred to as the "Appointed Surgeon") shall be appointed by the occupier for each factory, such appointment to be subject to the approval of the Chief Inspector.

(b) No person shall be employed in a lead process for more than a week without a certificate of fitness granted after examination by the Appointed Surgeon.

(c)[†] Every person employed in a lead process shall be examined once a week by the Appointed Surgeon, who shall have power to order suspension from employment in any place or process.

(d) No person after such suspension shall be employed in a lead process without the written sanction of the Appointed Surgeon.

(e) A Register in a form approved by the Chief Inspector of Factories shall be kept, and shall contain a list of all persons employed in lead processes. The Appointed Surgeon will enter in the Register the dates and results of his examinations of the persons employed, and particulars of any directions given by him. The Register shall be produced at any time when required by H.M. Inspectors of Factories or by the Certifying Surgeon or by the Appointed Surgeon.

13. Upon any person employed in a lead process complaining of being unwell, the occupier shall, with the least possible delay, give an order upon a duly qualified medical practitioner.

14. The occupier shall provide and maintain sufficient and suitable respirators, overalls, and head-coverings, and shall cause them to be worn as directed in Rule 29.

At the end of every day's work they shall be collected and kept in proper custody in a suitable place set apart for the purpose.

They shall be thoroughly washed or renewed every week; and those which have been used in the stoves, and all respirators, shall be washed or renewed daily.

15. The occupier shall provide and maintain a dining-room and a cloak-room in which workers can deposit clothing put off during working hours.

16. No person employed in a lead process shall be allowed to prepare or partake of any food or drink except in the dining-room or kitchen.

17. A supply of a suitable sanitary drink, to be approved by the Appointed Surgeon, shall be kept for the use of the workers.

18. The occupier shall provide and maintain a lavatory for the use of the workers, with soap, nail brushes, and at least one lavatory basin for every five persons employed. Each such basin shall be fitted with a waste pipe. There shall be a constant supply of hot and cold water laid on, except where there is no available public water service, in which case the provision of hot and cold water shall be such as shall satisfy the Inspector in charge of the district.*

The lavatory shall be thoroughly cleaned and supplied with clean towels after every meal.

There shall, in addition, be means of washing in close proximity to the workers of each department, if required by notice in writing from the Inspector in charge of the district.

There shall be facilities, to the satisfaction of the Inspector in charge of the district, for the workers to wash out their mouths.

19. Before each meal, and before the end of the day's work, at least ten minutes in addition to the regular meal times, shall be allowed to each worker for washing.

A notice to this effect shall be affixed in each department.

20.† The occupier shall provide and maintain sufficient baths and dressing rooms for all persons employed in lead processes, with hot and cold water, soap and towels, and shall cause each such person to take a bath once a week at the factory.

*The following Rule is in force in one works in substitution for Rule 12 (c):—

"Every person employed in a lead process shall once in each calendar month, on a date of which notice shall be given to every such person, be examined by the Appointed Surgeon who shall have power to suspend from employment in any lead process."

†The following Rule is in force in certain works in substitution for paragraph 1 of Rule 18:—

"The occupier shall provide and maintain in a cleanly state and in good repair for the use of persons employed a lavatory containing either

"(a) At least one lavatory basin for every five such persons, fitted with a waste pipe, or placed in a trough having a waste pipe, and having a constant supply of hot and cold water, or warm water, laid on; or

"(b) Troughs of enamel or similar smooth, impervious material, fitted with waste pipes without plugs, and having a constant supply of hot and cold water, or warm water, laid on. The length of such troughs shall be in a proportion of not less than 2 feet for every five persons employed.

"He shall also provide in the lavatory, soap, nail brushes, and a sufficient supply of towels."

‡The following proviso to Rule 20 is in force in one works:—

"Provided that this Rule shall not apply if the Chief Inspector of Factories approves the use of the local public baths when conveniently near, under the conditions (if any) named in such approval."

A bath register shall be kept, containing a list of all persons employed in lead processes, and an entry of the date when each person takes a bath.

This register shall be produced at any time when required by H.M. Inspectors of Factories or by the Certifying Surgeon or by the Appointed Surgeon.

21. The dressing rooms, baths, and w.c.'s shall be cleaned daily.

22. The floor of each workroom shall be cleaned daily, after being thoroughly damped.

Duties of Persons Employed.

23. No person shall strip a white bed or empty a chamber without previously effectually damping, as directed in Rules 2 and 3.

24. No person shall carry corrosions, or put them into the rollers or washbecks, otherwise than as permitted by Rule 4.

25. No person shall set or draw a stove otherwise than as permitted by Rules 6 and 7.

26. No person shall deposit or pack dry white lead otherwise than as permitted by Rules 8 and 9.

27. Every person employed in a lead process shall present himself at the appointed times for examination by the Appointed Surgeon, as provided in Rule 12.

28. No person, after suspension by the Appointed Surgeon, shall work in a lead process without his written sanction.

29. Every person engaged in

White beds,
Emptying chambers,
Rollers, washbecks, or grinding,
Setting or drawing stoves,
Packing,
Paint mixing,
Handling dry white lead,

or in any work involving exposure to white lead dust, shall, while so occupied, wear an overall suit and head-covering.

Every person engaged in stripping white beds, or in emptying chambers, or in drawing stoves, or in packing, shall in addition wear a respirator while so occupied.

30. Every person engaged in any place or process named in Rule 29 shall, before partaking of meals or leaving the premises, deposit the overalls, head coverings, and respirators in the place appointed by the occupier for the purpose, and shall thoroughly wash face and hands in the lavatory.

31.* Every person employed in a lead process shall take a bath at the factory at least once a week, and wash in the lavatory before bathing; having done so, he shall at once sign his name in the bath register, with the date.

32. No person employed in a lead process shall smoke or use tobacco in any form, or partake of food or drink, elsewhere than in the dining room or kitchen.

33. No person shall in any way interfere, without the knowledge and concurrence of the occupier or manager, with the means and appliances provided for the removal of dust.

34. The foreman shall report to the manager, and the manager shall report to the occupier, any instance coming under his notice of a worker neglecting to observe these Rules.

35. No person shall obtain employment under an assumed name or under any false pretence.

(2) For the manufacture of electric accumulators.¹

1903, No. 1004

Whereas the manufacture of electric accumulators has been certified in pursuance of Section 79 of the Factory and Workshop Act, 1901, to be dangerous;

I hereby, in pursuance of the powers conferred upon me by that Act, make the following regulations, and direct that they shall apply to all factories and workshops or parts thereof, in which electric accumulators are manufactured.

In these regulations "*lead process*" means pasting, casting, lead burning, or any work involving contact with dry compounds of lead.

Any approval given by the Chief Inspector of Factories in pursuance of these regulations shall be given in writing, and may at any time be revoked by notice in writing signed by him.

Duties of occupier.

1. Every room in which casting, pasting, or lead burning is carried on, shall contain at least 500 cubic feet of air space for each person employed therein, and in computing this air space, no height above fourteen feet shall be taken into account.

These rooms and that in which the plates are formed, shall be capable of thorough ventilation. They shall be provided with windows made to open.

*The following Rule is in force in one works in substitution for Rule 31:—

"Every person employed in a lead process shall take a bath at least once a week."

¹ Factory and Workshop Orders, 1919 edition, pp. 62-65.

2. Each of the following processes shall be carried on in such manner and under such conditions as to secure effectual separation from one another and from any other process.

- (a) Manipulation of dry compounds of lead;
- (b) Pasting;
- (c) Formation and lead burning necessarily carried on therewith;
- (d) Melting down of old plates.

Provided, That manipulation of dry compounds of lead carried on as in regulation 5 (b) need not be separated from pasting.

3. The floors of the rooms in which manipulation of dry compounds of lead or pasting is carried on shall be of cement or similar impervious material, and shall be kept constantly moist while work is being done.

The floors of these rooms shall be washed with a hose pipe daily.

4. Every melting pot shall be covered with a hood and shaft so arranged as to remove the fumes and hot air from the workrooms.

Lead ashes and old plates shall be kept in receptacles specially provided for the purpose.

5. Manipulation of dry compounds of lead in the mixing of the paste or other processes shall not be done except (a) in an apparatus so closed, or so arranged with an exhaust draught as to prevent the escape of dust into the workroom; or (b) at a bench provided with (1) efficient exhaust draft and air guide so arranged as to draw the dust away from the worker, and (2) a grating on which each receptacle of the compound of lead in use at the time shall stand.

6. The benches at which pasting is done shall be covered with sheet lead or other impervious material, and shall have raised edges.

7. No woman, young person or child shall be employed in the manipulation of dry compounds of lead or in pasting.

8. (a) A duly qualified medical practitioner (in these regulations referred to as the "appointed surgeon") who may be the certifying surgeon, shall be appointed by the occupier, such appointment unless held by the certifying surgeon to be subject to the approval of the Chief Inspector of Factories.

(b) Every person employed in a lead process shall be examined once a month by the Appointed Surgeon, who shall have power to suspend from employment in any lead process.

(c) No person after such suspension shall be employed in a lead process without written sanction entered in the Health Register by the Appointed Surgeon. It shall be sufficient compliance with this regulation for a written certificate to be given by the Appointed Surgeon and attached to the Health Register, such certificate to be replaced by a proper entry in the Health Register at the Appointed Surgeon's next visit.

(d) A Health Register in a form approved by the Chief Inspector of Factories shall be kept, and shall contain a list of all persons employed in lead processes. The Appointed Surgeon will enter in the Health Register the dates and results of his examinations of the persons employed and particulars of any directions given by him. He shall on a prescribed form furnish to the Chief Inspector of Factories on the 1st day of January in each year a list of the persons suspended by him during the previous year, the cause and duration of such suspension, and the number of examinations made.

The Health Register shall be produced at any time when required by H. M. Inspectors of Factories or by the Certifying Surgeon or by the Appointed Surgeon.

9. Overalls shall be provided for all persons employed in manipulating dry compounds of lead or in pasting.

The overalls shall be washed or renewed once every week.

10. The occupier shall provide and maintain:

(a) A cloakroom in which workers can deposit clothing put off during working hours. Separate and suitable arrangements shall be made for the storage of the overalls required in regulation 9.

(b) A dining-room, unless the factory is closed during meal hours.

11. No person shall be allowed to introduce, keep, prepare or partake of any food, drink, or tobacco, in any room in which a lead process is carried on. Suitable provisions shall be made for the deposit of food brought by the workers.

This regulation shall not apply to any sanitary drink provided by the occupier and approved by the appointed surgeon.

12. The occupier shall provide and maintain for the use of the persons employed in lead processes a lavatory, with soap, nailbrushes, towels, and at least one lavatory basin for every five such persons. Each such basin shall be provided with a waste pipe, or the basins shall be placed on a trough fitted with a waste pipe. There shall be a constant supply of hot and cold water laid on to each basin.

Or, in the place of basins, the occupier shall provide and maintain troughs of enamel or similar smooth impervious material, in good repair, of a total length of 2 feet for every five persons employed, fitted with waste pipes, and without plugs, with a sufficient supply of warm water constantly available.

The lavatory shall be kept thoroughly cleansed and shall be supplied with a sufficient quantity of clean towels once every day.

13. Before each meal and before the end of the day's work, at least 10 minutes, in addition to the regular meal times, shall be allowed for washing to each person who has been employed in the manipulation of dry compounds of lead or in pasting.

Provided, That if the lavatory accommodation specially reserved for such persons exceeds that required by regulation 12, the time allowance may be proportionately reduced, and that if there be one basin or 2 feet of trough for each such person this regulation shall not apply.

14. Sufficient bath accommodation shall be provided for all persons engaged in the manipulation of dry compounds of lead or in pasting, with hot and cold water laid on, and a sufficient supply of soap and towels.

This rule shall not apply if in consideration of the special circumstances of any particular case the Chief Inspector of Factories approves the use of local public baths when conveniently near, under the conditions (if any) named in such approval.

15. The floors and benches of each workroom shall be thoroughly cleansed daily, at a time when no other work is being carried on in the room.

Duties of persons employed.

16. All persons employed in lead processes shall present themselves at the appointed times for examination by the appointed surgeon as provided in regulation 8.

No person after suspension shall work in a lead process, in any factory or workshop in which electric accumulators are manufactured, without written sanction entered in the Health Register by the Appointed Surgeon.

17. Every person employed in the manipulation of dry compounds of lead or in pasting shall wear the overalls provided under regulation 9. The overalls, when not being worn, and clothing put off during working hours, shall be deposited in the places provided under regulation 10.

18. No person shall introduce, keep, prepare, or partake of any food, drink (other than any sanitary drink provided by the occupier and approved by the Appointed Surgeon), or tobacco in any room in which a lead process is carried on.

19. No person employed in a lead process shall leave the premises or partake of meals without previously and carefully cleaning and washing the hands.

20. Every person employed in the manipulation of dry compounds of lead or in pasting shall take a bath at least once a week.

21. No person shall in any way interfere, without the concurrence of the occupier or manager, with the means and appliances provided for the removal of the dust or fumes, and for the carrying out of these regulations.

These regulations shall come into force on the 1st day of January, 1904.

A. AKERS-DOUGLAS,
*One of His Majesty's Principal
Secretaries of State.*

Home Office, Whitehall,
21st November, 1903.

(3) For the process of file-cutting by hand.¹

1903, No. 507

Whereas the process of file-cutting by hand has been certified, in pursuance of section 79 of The Factory and Workshop Act, 1901,* to be dangerous:

I hereby, in pursuance of the powers conferred on me by that Act, make the following Regulations, and direct that they shall apply to all factories and workshops (including tenement factories and tenement workshops) or parts thereof in which the process of file-cutting by hand is carried on: *Provided* that the Chief Inspector of Factories may by certificate in writing exempt from all or any of these Regulations any factory or workshop in which he is satisfied that the beds used are of such composition as not to entail danger to the health of the persons employed.

1. The number of stocks in any room shall not be more than one stock for every 350 cubic feet of air space in the room; and in calculating air space for the purpose of this Regulation, any space more than 10 feet above the floor of the room shall not be reckoned.

2. After the 1st day of January, 1904, the distance between the stocks measured from the centre of one stock to the centre of the next shall not be less than 2 feet 6 inches, and after the 1st day of January, 1905, the said distance shall not be less than 3 feet.

3. Every room shall have a substantial floor, the whole of which shall be covered with a washable material, save that it shall be optional to leave a space not exceeding 6 inches in width round the base of each stock.

The floor of every room shall be kept in good repair.

4. Efficient inlet and outlet ventilators shall be provided in every room. The inlet ventilators shall be so arranged and placed as not to cause a direct draught of incoming air to fall on the workmen employed at the stocks.

The ventilators shall be kept in good repair and in working order.

5. No person shall interfere with or impede the working of the ventilators.

6. Sufficient and suitable washing conveniences shall be provided and maintained for the use of the file-cutters. The washing conveniences shall be under cover and shall comprise at

¹ Factory and Workshop Orders, 1919 edition, pp. 60-62.

* 1 Edw. 7, c. 22.

least one fixed basin for every ten or less stocks. Every basin shall be fitted with a waste pipe discharging over a drain or into some receptacle of a capacity at least equal to one gallon for every file-cutter using the basin. Water shall be laid on to every basin either from the main or from a tank of a capacity of not less than $1\frac{1}{2}$ gallons to every worker supplied from such tank. A supply of clean water shall be kept in the said tank while work is going on, at least sufficient to enable every worker supplied from such tank to wash.

7. The walls and ceiling of every room, except such parts as are painted or varnished or made of glazed brick, shall be limewashed once in every six months ending the 30th of June, and once in every six months ending the 31st of December.

8. The floor and such parts of the walls and ceiling as are not limewashed and the benches shall be cleansed once a week.

9. If the factory or workshop is situated in a dwelling-house, the work of file-cutting shall not be carried on in any room which is used as a sleeping place or for cooking or eating meals.

10. Every file-cutter shall when at work wear a long apron reaching from the shoulders and neck to below the knees. The apron shall be kept in a cleanly state.

11. A copy of these Regulations, and an Abstract of the provisions of The Factory and Workshop Act, 1901,* shall be kept affixed in the factory or workshop in a conspicuous place.

12. It shall be the duty of the occupier to carry out Regulations 1, 2, 3, 4, 6, 7 and 11; except that, in any room in a tenement factory or tenement workshop which is let to more than one occupier, it shall be the duty of the owner to carry out these Regulations, except the last clause of Regulation 6, which shall be carried out by the occupiers.

It shall be the duty of the occupier or occupiers to carry out Regulation 8.

It shall be the duty of the occupier or occupiers and of every workman to observe Regulations 5, 9, and 10.

These Regulations shall come into force on the 1st day of September, 1903.

A. AKERS-DOUGLAS,
*One of His Majesty's Principal
Secretaries of State.*

Home Office, Whitehall,
19th June, 1903.

(4) For the manufacture of paints and colours.¹

1907, No. 17

Whereas the manufacture of paints and colours has been certified in pursuance of section 79 of The Factory and Workshop Act, 1901,* to be dangerous:

I hereby in pursuance of the powers conferred on me by that Act make the following Regulations, and direct that they shall apply to all factories and workshops in which dry carbonate of lead or red lead is used in the manufacture of paints and colours or chromate of lead is produced by boiling, provided as follows:

(1) The Regulations shall not apply to factories and workshops in which paints and colours are manufactured not for sale but solely for use in the business of the occupier; or to factories or workshops in which only the manufacture of artists' colours is carried on; or to the manufacture of varnish paints.

(2) Regulation 2, and so much of Regulation 3 as prevents the employment of a woman in manufacturing *lead colour*, shall not apply to the packing in parcels or kegs not exceeding 14 pounds in weight, unless and until so required by notice in writing from the Chief Inspector of Factories.

(3) Regulations 4, 5, 6, 11, and 12, shall not apply to factories or workshops in which the grinding of *lead colour* occupies less than three hours in any week, unless and until so required by notice in writing from the Chief Inspector of Factories.

†Definitions.

For the purpose of these Regulations:

"*Lead colour*" means dry carbonate of lead and red lead, and any colour into which either of these substances enters.

"*Lead process*" means any process involving the mixing, crushing, sifting, grinding in oil, or any other manipulation of *lead colour* giving rise to dust; or the manufacture and manipulation of chromate of lead produced by boiling in the colour house.

It shall be the duty of the occupier to observe Part I of these Regulations.

It shall be the duty of all persons employed to observe Part II of these Regulations.

* 1 Edw. 7, c. 22.

1 Factory and Workshop Orders, [1919] edition, pp. 86-88.

†The terms "*lead colour*" and "*lead process*" to which defined meanings are given are printed throughout in italics.

PART I.

DUTIES OF EMPLOYERS.

1. No *lead colour* shall be placed in any hopper or shoot without an efficient exhaust draught and air guide so arranged as to draw the dust away from the worker as near as possible to the point of origin.

2. No *lead process* shall be carried on, save either:

- (a) with an efficient exhaust draught and air guide so arranged as to carry away the dust or steam as near as possible to the point of origin; or
- (b) In the case of processes giving rise to dust, in an apparatus so closed as to prevent the escape of dust.

Provided that this Regulation shall not apply to the immersion and manipulation of *lead colour* in water.

3. No woman, young person, or child shall be employed in manipulating *lead colour*.

4. Every person employed in a *lead process* or at the roller mills connected with the grinding in oil of *lead colour* (hereinafter referred to as the *roller mills**) shall once in each calendar month, on a date of which notice shall be given to every such person, be examined by the Certifying Surgeon of the district or other duly qualified medical practitioner (hereinafter referred to as the Appointed Surgeon) if appointed for the purpose by the Chief Inspector of Factories by a certificate under his hand and subject to such conditions as may be specified in that certificate.

The Certifying or Appointed Surgeon shall have power to suspend from employment in any *lead process* or at the *roller mills*.

5. No person after suspension in accordance with Regulation 4 shall be employed in any *lead process* or at the *roller mills* without written sanction entered in the Health Register by the Certifying or Appointed Surgeon.

6. A Health Register in a form approved by the Chief Inspector of Factories shall be kept and shall contain a list of all persons employed in any *lead process* or at the *roller mills*. The Certifying or Appointed Surgeon will enter therein the dates and results of his examinations of such persons with particulars of any directions given by him.

The Health Register shall be produced at any time when required by any of His Majesty's Inspectors of Factories or by the Certifying or Appointed Surgeon.

7. Overalls shall be provided for all persons employed in *lead processes* or at the *roller mills*; and shall be washed or renewed at least once every week.

8. The occupier shall provide and maintain for the use of all persons employed in *lead processes* or at the *roller mills*:

- (a) a cloak-room or other suitable place in which such persons can deposit clothing put off during working hours, and separate and suitable arrangements for the storage of overalls required by Regulation 7.
- (b) a dining-room, unless all workers leave the factory during meal hours.

9. No person shall be allowed to introduce, keep, prepare, or partake of any food, drink (other than a medicine provided by the occupier and approved by the Certifying or Appointed Surgeon), or tobacco in any room in which a *lead process* is carried on. Suitable provision shall be made for the deposit of food brought by persons employed.

10. The occupier shall provide and maintain in a cleanly state and in good repair for the use of persons employed in *lead processes* or at the *roller mills* a lavatory containing either:

- (a) at least one lavatory basin for every five such persons, fitted with a waste pipe or placed in a trough having a waste pipe, and having a constant supply of cold water laid on, and a sufficient supply of hot water constantly available; or
- (b) troughs of enamel or similar smooth impervious material, fitted with waste pipes without plugs, and having a constant supply of warm water laid on. The length of such troughs shall be in a proportion of not less than two feet for every five persons employed in *lead processes* or at the *roller mills*.

He shall also provide in the lavatory soap, nail brushes, and a sufficient supply of clean towels renewed daily.

PART II.

DUTIES OF PERSONS EMPLOYED.

11. All persons employed in *lead processes* or at the *roller mills* shall present themselves at the appointed time for examination by the Certifying or Appointed Surgeon as provided in Regulation 4.

12. No person after suspension under Regulation 4 shall work in a *lead process* or at the *roller mills* in any paint and colour factory or workshop to which these Regulations apply without written sanction entered in the Health Register by the Certifying or Appointed Surgeon.

13. All persons employed in *lead processes* or at the *roller mills* shall wear the overalls provided under Regulation 7 and shall deposit such overalls and any clothing put off during working hours in the places provided under Regulation 8.

*The term "roller mills" to which a defined meaning is given is printed throughout in italics.

The overalls shall not be removed by persons employed from the factory or workshop.

14. No person shall introduce, keep, prepare, or partake of any food, drink (other than a medicine provided by the occupier and approved by the Certifying or Appointed Surgeon), or tobacco in any room in which a *lead process* is carried on.

15. All persons employed in *lead processes* or at the *roller mills* shall carefully clean and wash their hands before leaving the premises or partaking of any food.

16. No person shall, without the permission of the occupier or manager, interfere in any way with the means and appliances provided for the removal of dust, steam or fumes and for the carrying out of these Regulations.

These Regulations shall come into force on the 1st February, 1907.

H. J. GLADSTONE,
One of His Majesty's Principal
Secretaries of State.

Home Office, Whitehall,
21st January, 1907.

(5) For the heading of yarn dyed by means of a lead compound.¹

1907, No. 616

Whereas the process of *heading* of yarn dyed by means of a lead compound has been certified in pursuance of Section 79 of The Factory and Workshop Act, 1901,* to be dangerous;

I hereby, in pursuance of the powers conferred on me by that Act, make the following Regulations, and direct that they shall apply to all factories in which the said process is carried on.

Provided that if the Chief Inspector of Factories is satisfied, with regard to any such factory, that the *heading* of yarn dyed by means of a lead compound will not occupy more than three hours in any week, he may, by certificate, suspend Regulations 2, 3, 4, 7 (a) and 8 (a), or any of them. Every such certificate shall be in writing, signed by the Chief Inspector of Factories, and shall be revocable at any time by further certificate.

‡Definitions.

"*Heading*" means the manipulation of yarn dyed by means of a lead compound over a bar or post, and includes picking, making-up, and noddling.

"*Employed*" means employed in *heading* of yarn dyed by means of a lead compound.

"*Surgeon*" means the Certifying Factory Surgeon of the district or a duly qualified medical practitioner appointed by certificate under the hand of the Chief Inspector of Factories, which appointment shall be subject to such conditions as may be specified in that certificate.

"*Suspension*" means suspension by written certificate in the Health Register, signed by the *Surgeon*, from employment in *heading* of yarn dyed by means of a lead compound.

Duties.

It shall be the duty of the occupier to observe Part I of these Regulations.

It shall be the duty of all persons *employed* to observe Part II of these Regulations.

PART I.

DUTIES OF EMPLOYER.

1. No yarn dyed by means of a lead compound shall be *headed* unless there be an efficient exhaust draught so arranged as to draw the dust away from the worker, as near as possible to the point of origin. The speed of the draught at the exhaust opening shall be determined at least once in every three months and recorded in the General Register.

2. No person under 16 years of age shall be *employed*.

3. A Health Register, containing the names of all persons *employed*, shall be kept in a form approved by the Chief Inspector of Factories.

4. Every person *employed* shall be examined by the *Surgeon* once in every three months (or at shorter intervals if and as required in writing by the Chief Inspector of Factories) on a date of which due notice shall be given to all concerned.

The *Surgeon* shall have power of *suspension* as regards all persons *employed*, and no person after *suspension* shall be *employed* without written sanction from the *Surgeon* entered in the Health Register.

5. There shall be provided and maintained for the use of all persons *employed*:

(a) a suitable cloakroom for clothing put off during working hours;

(b) a suitable meal-room separate from any room in which *heading* of yarn dyed by means of a lead compound is carried on, unless the works are closed during meal hours; and, if so required by notice in writing from the Chief Inspector of Factories,

¹ Factory and Workshop Orders, 1919 edition, pp. 89-91.)

* 1 Edw. 7, c. 22.

‡ Terms to which defined meanings are given are printed throughout in italics.

- (c) suitable overalls and head-coverings, which shall be collected at the end of every day's work, and be washed and renewed at least once every week;
 - (d) a suitable place, separate from the cloakroom and mealroom, for the storage of the overalls and head-coverings.
6. There shall be provided and maintained in a cleanly state and in good repair, for the use of all persons *employed*, a lavatory, under cover, with a sufficient supply of clean towels, renewed daily, and of soap and nail brushes, and with either
- (a) a trough with a smooth, impervious surface, fitted with a waste pipe without plug, and of such length as to allow at least two feet for every five such persons, and having a constant supply of warm water from taps or jets above the trough at intervals of not more than two feet; or
 - (b) at least one lavatory basin for every five such persons, fitted with a waste pipe and plug or placed in a trough having a waste pipe, and having either a constant supply of hot and cold water or warm water laid on, or (if a constant supply of heated water be not reasonably practicable) a constant supply of cold water laid on and a supply of hot water always at hand when required for use by persons *employed*.

PART II.

DUTIES OF PERSONS EMPLOYED.

7. Every person *employed* shall:

- (a) present himself at the appointed time for examination by the *Surgeon* as provided in Regulation 4;
- (b) wear the overall and head-covering (provided in pursuance of Regulation 5 (c)) while at work, and shall remove them before partaking of food or leaving the premises, and shall deposit in the cloakroom, provided in pursuance of Regulation 5 (a), clothing put off during working hours;
- (c) wash the hands before partaking of food or leaving the premises.

8. No person shall:

- (a) work in *heading* of yarn dyed by means of a lead compound after *suspension*, without written sanction from the *Surgeon* entered in the Health Register;
- (b) introduce, keep, prepare, or partake of any food or drink, or tobacco, in any room in which *heading* of yarn dyed by means of a lead compound is carried on;
- (c) interfere in any way, without the concurrence of the occupier or manager, with the means and appliances provided for the removal of the dust, and for the carrying out of these Regulations.

H. J. GLADSTONE,
*One of His Majesty's Principal
 Secretaries of State.*

Home Office, Whitehall,
 6th August, 1907.

(6) For vitreous enamelling of metal or glass.¹
 1908, No. 1258

Whereas the process of vitreous enamelling of metal or glass has been certified in pursuance of section 79 of The Factory and Workshop Act, 1901, to be dangerous;

I hereby, in pursuance of the powers conferred on me by that Act, make the following Regulations, and direct that they shall apply to all factories and workshops in which vitreous enamelling of metal or glass is carried on.

Provided that nothing in these Regulations shall apply to

- (a) the *enamelling* of jewellery or watches; or
- (b) the manufacture of stained glass;
- (c) *enamelling* by means of glazes or colours containing less than 1 per cent. of lead.

These Regulations shall come into force on 1st April, 1909.

Definitions.*

In these Regulations,

"*Enamelling*" means crushing, grinding, sieving, dusting or laying on, brushing or woolling off, spraying, or any other process for the purpose of vitreous covering and decoration of metal or glass;

"*Employed*" means employed in *enamelling*;

"*Surgeon*" means the Certifying Factory Surgeon of the district or a duly qualified medical practitioner appointed by written certificate of the Chief Inspector of Factories, which appointment shall be subject to such conditions as may be specified in that certificate;

¹ Factory and Workshop Orders, 1919 edition, pp. 99-102.

* Terms to which defined meanings are given are printed throughout in italics.

"*Suspension*" means suspension by written certificate in the Health Register, signed by the Surgeon, from employment of any *enamelling* process.

Duties.

It shall be the duty of the occupier to observe Part I of these Regulations.

It shall be the duty of all persons employed to observe Part II of these Regulations.

PART I.

DUTIES OF EMPLOYERS.

1. Every room in which any *enamelling* process is carried on,
 - (a) shall contain at least 500 cubic feet of air space for each person employed therein, and in computing this air space no height above 14 feet shall be taken into account;
 - (b) shall be efficiently lighted, and shall for this purpose have efficient means of lighting both natural and artificial.
2. In every room in which any *enamelling* process is carried on,
 - (a) the floors shall be well and closely laid, and be maintained in good condition;
 - (b) the floors and benches shall be cleansed daily and kept free of collections of dust.
3. No *enamelling* process giving rise to dust or spray shall be done save either
 - (a) under conditions which secure the absence of dust and spray; or
 - (b) with an efficient exhaust so arranged as to intercept the dust or spray and prevent it from diffusing into the air of the room.
4. Except in cases where glaze is applied to a heated metallic surface, dusting or laying on, and brushing or woolling off, shall not be done except over a grid with a receptacle beneath to intercept the dust falling through.
5. If firing is done in a room not specially set apart for the purpose, no person shall be *employed* in any other process within 20 feet from the furnace.
6. Such arrangements shall be made as shall effectually prevent gases generated in the muffle furnaces from entering the workrooms.
7. No child or young person under 16 years of age shall be *employed* in any *enamelling* process.
8. A Health Register, containing the names of all persons *employed* shall be kept in a form approved by the Chief Inspector of Factories.
9. Every person *employed* shall be examined by the *Surgeon* once in every three months (or at such other intervals as may be prescribed in writing by the Chief Inspector of Factories) on a date of which due notice shall be given to all concerned.
10. The *Surgeon* shall have power of *suspension* as regards all persons *employed*, and no person after *suspension* shall be *employed* without written sanction from the *Surgeon* entered in the Health Register.
11. There shall be provided and maintained for the use of all persons *employed*,
 - (a) suitable overalls and head-coverings, which shall be collected at the end of every day's work, and be cleaned or renewed at least once every week;
 - (b) a suitable place, separate from the cloakroom and mealroom, for the storage of the overalls and head-coverings;
 - (c) a suitable cloakroom for clothing put off during working hours;
 - (d) a suitable mealroom separate from any room in which *enamelling* processes are carried on, unless the works are closed during meal hours.
12. There shall be provided and maintained in a cleanly state and in good repair, for the use of all persons *employed*, a lavatory, under cover, with a sufficient supply of clean towels, renewed daily, and of soap and nail brushes, and with either,
 - (a) a trough with a smooth, impervious surface, fitted with a waste pipe without plug, and of such length as to allow at least two feet for every five such persons, and having a constant supply of warm water from taps or jets above the trough at intervals of not more than two feet; or
 - (b) at least one lavatory basin for every five such persons, fitted with a waste pipe and plug or placed in a trough having a waste pipe, and having either a constant supply of hot and cold water or warm water laid on, or (if a constant supply of heated water be not reasonably practicable) a constant supply of cold water laid on and a supply of hot water always at hand when required for use by persons *employed*.
13. The occupier shall allow any of His Majesty's Inspectors of Factories to take at any time sufficient samples for analysis of any *enamelling* material in use or mixed for use.
 Provided that the occupier may at the time when the sample is taken, and on providing the necessary appliances, require the Inspector to take, seal and deliver to him a duplicate sample.
 No results of any analysis shall be published without the consent of the occupier, except such as may be necessary to prove the presence of lead when there has been infraction of the Regulations.

PART II.

DUTIES OF PERSONS EMPLOYED.

14. Every person *employed* shall:

- (a) present himself at the appointed time for examination by the *Surgeon* as provided in Regulation 9;
- (b) wear the overall and head-covering provided under Regulation II (a), and deposit them and clothing put off during working hours, in the places provided under Regulation II (b) and (c);
- (c) carefully clean the hands before partaking of any food or leaving the premises;
- (d) so arrange the hair that it shall be effectually protected from dust by the head-covering.

15. No person *employed* shall:

- (a) after *suspension*, work in any *enamelling* process without written sanction from the *Surgeon* entered in the Health Register;
- (b) introduce, keep, prepare, or partake of any food, drink, or tobacco, in any room in which an *enamelling* process is carried on;
- (c) interfere in any way, without the concurrence of the occupier or manager, with the means and appliances provided for the removal of dust or fumes, and for the carrying out of these Regulations.

H. J. GLADSTONE,

One of His Majesty's Principal
Secretaries of StateHome Office, Whitehall,
18th December, 1908.(7) For the tinning of metal hollow-ware, iron drums and harness furniture.¹
1909, No. 720

Whereas the coating of metal articles with a mixture of tin and lead, or lead alone, has been certified in pursuance of section 79 of The Factory and Workshop Act, 1901,* to be dangerous; I hereby, in pursuance of the powers conferred on me by that Act, make the following Regulations, and direct that they shall apply to all factories and workshops where *tinning* is carried on in the manufacture of metal hollow-ware, iron drums and harness furniture.

Provided that these Regulations shall not apply to:

- (a) Any process in silver plating;
 - (b) Any process in which a soldering iron is used;
 - (c) Any other process if and so far as it is exempted by written certificate of the Chief Inspector of Factories, on the ground that he is satisfied that any of these Regulations are not required for the protection of the persons employed, by reason of the intermittency or infrequency of the *tinning* or other special circumstance.
- Any such certificate of exemption shall be subject to the conditions therein prescribed and may be revoked at any time.

These Regulations shall come into force on October 1st, 1909, except that Regulation 1 shall come into force on April 1st, 1910.

‡Definitions.

In these Regulations:

"*Tinning*" means the dipping and wiping of any metal in the process of coating it with a mixture of tin and lead or lead alone where hydrochloric acid or any salt of that acid is used. "*Mounting*," "*denting*" and "*scouring*" mean the mounting, denting and scouring of hollow-ware articles tinned on the outer surface.

"*Surgeon*" means the Certifying Factory Surgeon of the district or a duly qualified medical practitioner appointed by written certificate of the Chief Inspector of Factories, which appointment shall be subject to such conditions as may be specified in that certificate.

"*Suspension*" means suspension from employment in *tinning* by written certificate in the Health Register, signed by the Surgeon.

"*Efficient draught*" means localized ventilation effected by heat or mechanical means for the removal of fumes or dust so as to prevent them as far as practicable from escaping into the air of any room in which work is carried on.

No draught shall be deemed efficient which fails so to remove smoke generated at the point where such fumes or dust originate.

Duties.

It shall be the duty of the occupier to observe Part I of these Regulations.

It shall be the duty of all persons employed to observe Part II of these Regulations.

¹ Factory and Workshop Orders, 1919 edition, pp. 116-119.

* 1 Edw. 7, c. 22.

‡Terms to which defined meanings are given are printed throughout in italics.

PART I.

DUTIES OF EMPLOYERS.

1. No *tinning* shall be carried on except under an *efficient draught*.

The article to be tinned shall not be removed from such draught from the time when dipping is commenced until wiping is completed.

This Regulation shall not apply to the wiping of sheet metal 18 inches or more in length, where the person employed is wiping such sheet metal for his own use in some other process of his work.

2. No person under 16 years of age shall be employed in *tinning*.

3. The skimmings from the dipping bath shall not be removed from under the *efficient draught* until they have been placed in a covered receptacle. When removed they shall not be deposited in any room in which work is carried on.

4. The dust and refuse collected from the floor shall not be deposited in any room in which work is carried on.

5. A Health Register containing the names of all persons employed in *tinning* shall be kept in a form approved by the Chief Inspector of Factories.

6. Every person employed in *tinning* shall be examined by the *Surgeon* once in every three months (or at such shorter or longer intervals as may be prescribed in writing by the Chief Inspector of Factories) on a day of which due notice shall be given to all concerned.

The *Surgeon* shall have the power of *suspension* as regards all persons employed in *tinning*, and no such person after *suspension* shall be employed in *tinning* without written sanction from the *Surgeon* entered in the Health Register.

7. There shall be provided for the use of all women employed in *tinning*:

- (a) a cloak-room, or other suitable place, separate from any room in which work is carried on, for clothing put off during working hours;
- (b) aprons or other equivalent protection.

8. There shall be provided for the use of all persons employed in *tinning*, *mounting*, *denting*, or *scouring*, a room separate from any room in which such work is carried on, where such persons may have meals, unless the works are closed during meal hours.

9. There shall be provided and maintained in a cleanly state and good repair for the use of all persons employed in *tinning*, *mounting*, *denting*, or *scouring*, a lavatory, under cover, with a sufficient supply of clean towels, renewed daily, and of soap and nail brushes, and with either:

- (a) a trough with a smooth, impervious surface, fitted with a waste pipe without plug, and of such length as to allow at least two feet for every five persons, and having a constant supply of warm water from taps or jets above the trough at intervals of not more than two feet; or,
- (b) at least one lavatory basin for every five such persons, fitted with a waste pipe and plug, and having either a constant supply of hot and cold water or warm water laid on, or (if a constant supply of heated water be not reasonably practicable) a constant supply of cold water laid on, and a supply of hot water always at hand when required for use by persons employed.

PART II.

DUTIES OF PERSONS EMPLOYED.

10. Every person employed in *tinning* shall present himself at the appointed time for examination by the *Surgeon* as provided in Regulation 6.

11. No person employed in *tinning* shall

- (a) After *suspension*, work at *tinning* without written sanction from the *Surgeon* entered in the Health Register; or
- (b) Interfere in any way, without the concurrence of the occupier or manager, with the means and appliances provided for the removal of dust or fumes, and for the carrying out of these Regulations.

12. Every person employed in *tinning*, *mounting*, *denting*, or *scouring*, shall wash the hands before partaking of food or leaving the premises.

13. No person employed in *tinning*, *mounting*, *denting*, or *scouring*, shall keep or prepare or partake of any food or alcoholic drink in any room in which such work is carried on.

H. J. GLADSTONE,
One of His Majesty's Principal
Secretaries of State.

(8) For the smelting of materials containing lead, the manufacture of red or orange lead, and the manufacture of flaked litharge.¹

1911, No. 752

In pursuance of section 79 of The Factory and Workshop Act, 1901,* I hereby make the following Regulations and direct that they shall apply to all factories and workshops or parts thereof (other than laboratories), in which any of the following processes are carried on:

The Smelting of Materials containing Lead;
The Manufacture of Red or Orange Lead;
The Manufacture of Flaked Litharge.

These Regulations shall come into force on October 1st, 1911, except that so much of Regulations 2 and 3 as requires the provision of *efficient exhaust draught* shall come into force on May 1st, 1912.

‡Definitions.

In these Regulations:

"*Lead material*" means

- (i) material containing not less than five per cent. of lead, including lead ore, bullion ore (lead ore rich in precious metals), red lead, orange lead, and flaked litharge; and
- (ii) zinc ore, and material resulting from the treatment thereof, containing not less than two per cent. of lead;

except ores which contain lead only in the form of sulphide of lead.

"*Furnace*," "*melting pot*," "*retort*," "*condensing chamber*," mean structures as aforesaid which are used in the treatment of *lead material*.

"*Flue*" means a flue leading from a furnace.

"*Lead process*" means

- (i) manipulation, movement or other treatment of *lead material*, whether by means of any *furnace*, *melting pot*, *retort*, *condensing chamber*, *flue*, or otherwise; and
- (ii) cleaning or demolition of any *furnace*, *melting pot*, *retort*, *condensing chamber*, *flue*, or part thereof or reconstruction thereof with material which has formed part of any such structure.

"*Surgeon*" means the Certifying Factory Surgeon of the district or a duly qualified medical practitioner appointed by written certificate of the Chief Inspector of Factories, which appointment shall be subject to such conditions as may be specified in that certificate.

"*Suspension*" means suspension from employment in any *lead process* by written certificate in the Health Register, signed by the *Surgeon*, who shall have power of suspension as regards all persons employed in any *lead process*.

"*Damp*" means sufficiently moist to prevent the escape of dust.

"*Efficient exhaust draught*" means localized ventilation effected by heat or mechanical means, for the removal of gas, vapour, fumes or dust so as to prevent them (as far as practicable under the atmospheric conditions usually prevailing) from escaping into the air of any place in which work is carried on. No draught shall be deemed efficient which fails so to remove smoke generated at the point where such gas, vapour, fumes or dust originate.

Duties.

It shall be the duty of the occupier to observe Part I of these Regulations.

It shall be the duty of every person employed to observe Part II of these Regulations.

PART I.

DUTIES OF OCCUPIERS.

1. Where a *lead process* is carried on so as to give rise to dust or fumes,

(a) the floor, other than sand beds, shall be maintained in good condition; and

(b) the floor, except such portion as is permanently set apart for the deposit of *lead material*, shall be sprayed with water at least once a day.

2.—(1) No *lead material* (other than ingots of metal) shall be deposited or allowed to remain on any part of the floor not permanently set apart for the purpose, and no *lead material* (other than ingots of metal) shall be moved to a *furnace*, unless such *lead material* is

(a) *damp*; or

(b) under an *efficient exhaust draught*; or

(c) so enclosed as to prevent the escape of dust into the air of any place in which work is carried on.

(2) Provided, however, that where none of the above conditions are practicable, *lead material* may be moved to a *furnace* by persons wearing suitable respirators.

*1 Edw. 7, c. 22.

‡Terms to which defined meanings are given are printed throughout the Regulations in italics.

1 Factory and Workshop Orders, 1919 edition, pp. 123-127.

3. None of the following processes shall be carried on except with an *efficient exhaust draught*:
 melting old or dirty scrap lead;
 heating *lead material* so that vapour containing lead is given off;
 cooling molten flaked litharge;
 or, unless carried on in such manner as to prevent escape of gas, vapour, fumes or dust into any place in which work is carried on,
 feeding any *furnace or retort*;
 manipulating *lead material* in any *furnace or retort*;
 removing *lead material* from any *furnace or retort*;
 placing in any hopper or shoot, or packing, red or orange lead or flaked litharge.
4. No sack which has contained *lead material* shall be cleaned, and, except in the process of sampling, no *lead material* shall be broken up, crushed or ground, unless such sack or *lead material* is damp, or is placed in an apparatus so enclosed as to prevent the escape of dust.
5. No *lead material* giving off vapour containing lead shall be removed from the *efficient exhaust draught* required by Regulation 3, unless in a receptacle with an efficient cover.
6. No person shall be allowed to enter any *furnace, melting pot, retort, condensing chamber, or flue*, until it has been ventilated.
7. No person shall be allowed to remain in any *flue* (unless damp) or *condensing chamber* for more than three hours without an interval of at least half an hour.
8. There shall be provided suitable overalls for the use of all persons employed in any of the following processes; which overalls, when required for such use, shall be washed, cleaned or renewed at least once every week:
 - (a) cleaning any *flue* (unless damp) or *condensing chamber*;
 - (b) demolishing any part of a *furnace, melting pot, retort, condensing chamber, or flue*, unless either damp or under an *efficient exhaust draught*;
 - (c) reconstructing any part of a *furnace, melting pot, retort, condensing chamber, or flue*, with material which has formed part of any such structure, unless damp;
 - (d) breaking up, crushing, or grinding, in the process of sampling, *lead material* unless either damp or placed in an apparatus so enclosed as to prevent the escape of dust;
 - (e) placing in any hopper or shoot, or packing, red or orange lead or flaked litharge.
9. There shall be provided suitable respirators for the use of all persons employed in any process named in Regulation 2 (2) or in Regulation 8; which respirators, when required for such use, shall be washed or renewed at least once every day.
10. No person under 16 years of age, and no female, shall be employed in any *lead process*.
11. There shall be provided and maintained for the use of all persons employed in any *lead process*:
 - (a) a suitable meal room, unless the works are closed during meal hours;
 - (b) a suitable place or places for clothing put off during working hours; and
 - (c) a suitable place or places for the storage of overalls provided in pursuance of Regulation 8; which place or places shall be separate from those required by paragraphs (a) and (b) of this Regulation;
 all of which shall be so located as not to be exposed to dust or fumes from any manufacturing process.
12. There shall be provided and maintained in a cleanly state and in good repair for the use of all persons employed in any *lead process*:
 - (a) a lavatory, under cover, with a sufficient supply of clean towels, renewed daily, and of soap and nail brushes, and with either
 - (i) a trough with a smooth, impervious surface, fitted with a waste-pipe without plug, and of such length as to allow at least two feet for every five such persons employed at any one time, and having a constant supply of warm water from taps or jets above the trough at intervals of not more than two feet; or
 - (ii) at least one lavatory basin for every five such persons employed at any one time, fitted with a waste-pipe and plug, and having either a constant supply of hot and cold water, or warm water laid on, or (if a constant supply of heated water be not reasonably practicable) a constant supply of cold water laid on, and a supply of hot water always at hand when required for use by such persons; and
 - (b) sufficient and suitable bath accommodation (douche or other) with hot water laid on, unless the water supply provided under paragraph (a) is so arranged that a warm douche for the face, neck and arms can be taken.

Provided that, when the number of persons so employed at any one time is temporarily increased by reason of *flue* cleaning, it shall not be necessary to provide (by reason only of such temporary increase) additional accommodation in pursuance of paragraph (a) of this Regulation if adequate time is allowed to all such persons for washing immediately before each meal (in addition to the regular meal times) and immediately before the end of the day's work.

13. (a) Every person employed in a *lead process* shall be examined by the *Surgeon* once in every calendar month (or at such shorter or longer intervals as may be prescribed in writing by the Chief Inspector of Factories) on a date of which due notice shall be given.

(b) A Health Register containing the names of all persons employed in any *lead process* shall be kept in a form approved by the Chief Inspector of Factories.

(c) No person after *suspension* shall be employed in any *lead process* without written sanction from the *Surgeon*, entered in the Health Register.

PART II.

DUTIES OF PERSONS EMPLOYED.

14.—(a) Every person employed in any *lead process* shall deposit in the place or places provided in pursuance of Regulation 11 (b) all clothing put off during working hours.

(b) Every person for whose use an overall is provided in pursuance of Regulation 8 shall wear the overall when employed in any process named in that Regulation, and remove it before partaking of food or leaving the premises, and deposit it in the place provided under Regulation 11 (c).

(c) Every person for whose use a respirator is provided in pursuance of Regulation 9, shall wear the respirator while employed in any process to which Regulation 2 (2) or Regulation 8 applies.

15. No person employed shall introduce, keep, prepare or partake of any food or drink (other than a non-alcoholic drink approved by the *Surgeon*), or make use of tobacco, in any place in which any *lead process* is carried on;

Provided that, except in processes named in Regulation 8, this Regulation shall not prevent any person from using tobacco, other than a cigar or cigarette, if his hands are free from lead.

16. Every person employed in any *lead process*, or in any place where any *lead process* is being carried on, shall, before partaking of food, wash the face and hands, and before leaving the premises, wash the face, neck and arms, in the lavatory provided in pursuance of Regulation 12.

17. Every person employed in any *lead process* shall present himself at the appointed time for examination by the *Surgeon*, in pursuance of Regulation 13 (a).

18. No person employed shall, after *suspension* under these Regulations or under any other Regulations or Special Rules applying to factories or workshops where any process involving the use of lead is carried on, work in any *lead process* without written sanction from the *Surgeon*, entered in the Health Register.

19. No person employed shall interfere in any way, without the concurrence of the occupier or manager, with the means provided for the removal of gas, vapour, fumes and dust, and for the carrying out of these Regulations.

W. S. CHURCHILL,

One of His Majesty's Principal
Secretaries of State.

Home Office, Whitehall,
12th August, 1911.

(9) For the manufacture and decoration of pottery.*¹ 1913, No. 2

In pursuance of section 79 of The Factory and Workshop Act, 1901,† I hereby make the following Regulations, and direct that they shall apply to all factories and workshops in which the manufacture or decoration of *pottery* or any process incidental thereto is carried on; including factories and workshops in which lithographic transfers, frits, or glazes are made for use in the manufacture or decoration of *pottery*.

Provided that, if at any time it is shown to the satisfaction of the Secretary of State in the case of any manufacture or process or any operation forming part thereof, that injury to health is adequately prevented by other appliances or under other conditions than those prescribed by these Regulations, he may, by Order, modify the whole or any part of the Regulations, so far as they apply to such manufacture or process. Any such Order may be revoked, modified, or extended by further Order.

And provided, further, in regard to Regulation 10 (a), the Secretary of State may, by Order,

- (i) grant exemptions from this Regulation in the case of any special branch of the industry if it can be shown that every means has been tried for the purpose of conforming to the prescribed limit;
- (ii) substitute a limit higher than 70° Fahrenheit in the case of printing or other specified shops, if it can be shown to be necessary.

¹ Factory and Workshop Orders, 1919 edition, pp. 130-155.

*These Regulations were gazetted January 7, 1913.

†1 Edw. 7, c. 22.

‡Definitions.

In these Regulations:

"Pottery" includes earthenware, china, tiles and any other articles made from clay, with or without the addition of other material.

"Coarse ware" means pottery not shaped by compression of powdered material, and not fired more than once in the process of manufacture.

In the case of a fireclay works in which the ware is generally fired only once, the whole of the works may, with the approval in writing of the Chief Inspector of Factories, be regarded as a *coarseware* factory, notwithstanding that some of the clay ware is hardened by fire before any slip or body coating is applied to the fireclay body; subject, however, to the following conditions:

- (i) no slip or body coating shall be applied before such hardening;
- (ii) neither the ware so hardened nor any subsequently applied slip or body coating shall be sandpapered or treated by any other process which would generate dust;
- (iii) the approval of the Chief Inspector of Factories shall be kept attached to the general register, and shall be subject to the further conditions, if any, specified therein, and shall be revocable by further notice in writing.

"Leadless glaze" means a glaze which does not contain more than one per cent. of its dry weight of a lead compound calculated as lead monoxide.

"Low solubility glaze" means

- (1) a glaze which does not yield to dilute hydrochloric acid more than five per cent. of its dry weight of a soluble lead compound calculated as lead monoxide when determined in the manner described below; or
- (2) a glaze containing no lead or lead compound other than *galena*.

A weighed quantity of dried material is to be continuously shaken for one hour at the common temperature, with 1,000 times its weight of an aqueous solution of hydrochloric acid containing 0.25 per cent. of HCl. This solution is thereafter to be allowed to stand for one hour, and to be passed through a filter. The lead salt contained in an aliquot portion of the clear filtrate is then to be precipitated as lead sulphide, and weighed as lead sulphate.

"Galena" means the native sulphide of lead containing not more than five per cent. of a soluble lead compound calculated as lead monoxide when determined in the manner described in the definition of *low solubility glaze*. *Galena* shall not for the purpose of these Regulations be deemed to be an unfritted lead compound.

"Leadless glaze factory" means a factory the occupier of which has given an undertaking, to the satisfaction of the Chief Inspector of Factories, that none but *leadless glaze* shall be used therein, and in which none but *leadless glaze* is in fact used.

"Low solubility glaze factory" means a factory the occupier of which has given an undertaking, to the satisfaction of the Chief Inspector of Factories, that none but *low solubility glaze* shall be used therein, and in which none but *low solubility glaze* is in fact used.

"Majolica painting" includes painting in majolica or other glaze.

"Surgeon" means the Certifying Factory Surgeon of the district, who shall have, as regards all persons examined by him in pursuance of these Regulations, power of *suspension* and of *permission to work*, by certificate which may either be entered in the *Health Register* by the Surgeon personally, or be sent by him to the occupier.

"Entered in the Health Register" means

- (a) entered in the prescribed register kept at the Factory in pursuance of Regulation 3;

or

- (b) entered in the portable register prescribed for the use of casual workers.

"Suspension" means suspension, by signed certificate of the Surgeon, from employment in any process in which examination by the Surgeon is required by these Regulations.

"Permission to work" means permission, by signed certificate of the Surgeon, either

- (a) terminating a *suspension*, or
- (b) permitting employment of a certain specified kind.

"Potter's shops" includes any place where tiles or other articles are made by pressing clay dust, as well as every place where articles of *pottery* are shaped by a plastic or other process.

"Wedging of clay" means the treatment of clay which has not been pugged or rolled, by raising one piece of clay by hand and bringing it down upon another piece; but does not include the process frequently known as "slapping of clay," in which two pieces of clay, each small enough to be held in one hand, are slapped together.

"Workroom" shall not, for the purposes of Regulation 10, include any stove or drying chamber which is not entered by workers except for the purpose of carrying ware in or out or turning it.

"Bedding" means the placing of flat ware in powdered flint for the biscuit firing when the sagger or box containing the ware is filled up with powdered flint.

"Flinting" means the placing of flat ware in powdered flint for the biscuit firing when the sagger or box containing the ware is not filled up with powdered flint.

"Scouring" includes fine brushing, as well as sandpapering, brushing, and every other scouring process, as applied to biscuit ware.

‡Terms to which defined meanings are given are printed throughout in italics.

"*Stopping of biscuit ware*" means the filling up of cracks in ware which has been fired once and before glaze is applied to it.

"*Glost placing*" includes the operations of carrying saggars of ware into the glost oven and carrying them out again after the glost firing, as well as the operation of placing the ware in the saggars for glost firing; but not placing of ware on cranks or similar articles prior to their transfer to saggars or kilns by other persons.

"*Flow material*" means any material containing lead, which is placed in saggars, with a view to its entire or partial volatilization during the glost firing of the ware.

"*Thimble picking*" means the picking over, sorting, or rearranging for further use, of thimbles, stilts, spurs, strips, saddles, or any similar articles which have been used for the support of articles of *pottery* during the process of glost firing.

"*Efficient exhaust draught*" used in connection with a process means an exhaust draught which effectually removes, as near as possible to the point of origin, the dust generated in the process. No draught shall be deemed to be efficient which fails effectually to remove smoke generated at any point where dust originates in the process.

Duties.

It shall be the duty of the occupier to observe Part I of these Regulations.

It shall be the duty of all persons employed to observe Part II of these Regulations.

Exemptions.

1. The following Regulations* and parts of Regulations shall not apply to *leadless glaze* factories:

Paragraphs ii, iii, vi, vii, of Regulation 1 *a*;

Regulations 1 *f*, 1 *g*, 1 *h*, 1 *k*;

Paragraph xii of Regulation 7 *a*;

Regulations 7 *h*, 7 *k*, 7 *l*;

Paragraph ii of Regulation 8 *a*;

Regulation 12 *b*, so far as regards the processes marked *a* and *c* in the Schedule;

Regulations 12 *d*, 14, 15 *a*, 15 *b*, 16, 17 *a*, 17 *b*, 18;

Regulation 19, so far as regards factories in which *flow material* is not used;

Regulation 20;

Regulation 24 *a*, so far as regards threading up, and so far as regards *thimble picking* in factories in which *flow material* is not used;

Regulations 35 *a*, 35 *b*;

Regulations 1, 2, 3, 4, 5, 6, 11, 13, 17, 24, 25 (except 25 *a*, 25 *f*, 25 *g*), 26, 29, 30, 31, 33, 35, so far as regards the processes marked *a*, *b*, *c*, *d*, *e*, *f*, *g*, in Part I of the Schedule.

2. The following Regulations* and parts of Regulations shall not apply to *low solubility glaze* factories:

Paragraph iii of Regulation 1 *a*;

Regulations 1 *f*, 1 *g*, 1 *h*;

Paragraph xii of Regulation 7 *a*;

Regulation 7 *k*;

Regulation 12 *b*, so far as regards the process marked *c* in Part I of the Schedule;

Regulations 12 *d*, 15 *a*, 15 *b*, 16;

Regulation 19, so far as regards factories in which *flow material* is not used;

Regulation 24 *a*, so far as regards threading up, and so far as regards *thimble picking* in factories in which *flow material* is not used;

Regulations 2, 3, 29, so far as regards the processes marked *b*, *c*, *d*, *e*, *f*, *g*, in Part I of the Schedule.

If the occupier of a *low solubility glaze* factory satisfies the Chief Inspector of Factories that *leadless glaze* is used for a substantial part of the output, the Regulations and parts of Regulations named in Exemption 1 (except so far as regards the preparation or manufacture of frits or glazes) shall not apply to such factory unless and until so required by notice in writing from the Chief Inspector of Factories.

3. The following Regulations† and parts of Regulations shall not apply, unless and until so required by notice in writing from the Chief Inspector of Factories, to the manufacture of *coarse ware* in factories in which no *pottery* other than *coarse ware* is made:

Paragraphs i, iv, vii, viii, of Regulation 1*a*;

Regulations 7 *a* (except paragraph xii), 7 *e*, 7 *f*, 7 *g*;

Regulations 9, 10, 12 (except 12 *f* and 12 *g*), 13, 14 *c*, 16, 18, 19, 20, 21, 22, 23, 24 *a*;

All Regulations so far as regards the processes marked *h*, *k*, *l*, *m*, *n*, *o*, *p*, *q*, *r*, *s*, in the Schedule.

Nothing in Regulations 4, 5, 6, 8, 14, 17, 25, 30, 31, or 35, shall apply to *leadless glaze* factories or *low solubility glaze* factories in which no *pottery* other than *coarse ware* is made.

4. Nothing in these Regulations shall apply to the manufacture of sanitary or drain pipes; or bricks, glazed or unglazed; or unglazed or salt-glazed *coarse ware* in a factory in which no other *pottery* is made.

*The Regulations in question are marked *; or in the case of partial or conditional exemption (*).

†The Regulations in question are marked †; or in the case of partial or conditional exemption (†).

‡The Regulations in question are marked ‡, or in case of partial or conditional exemption (‡).

Nothing in these Regulations (except Regulation 28) shall apply to the manufacture of architectural terra-cotta, glazed or unglazed, made from plastic clay in a factory in which no lead is used.

5. Nothing in Regulations 4 and 30 shall be deemed to require overalls or head coverings to be provided for, or worn by, any man during the time he is engaged in drawing a glost oven.

Nothing in Regulations 12 or 13 shall be deemed to require the use of moisture in cleaning floors or work benches in lithographic transfer-making shops.

6. Men employed only as glost drawers shall not be deemed to be employed in a process included as Part I of the Schedule if they do not work in any place in which a process named in Part I of the schedule is being carried on.

PART I.

DUTIES OF OCCUPIERS.

*The Regulations in question are marked *; or in case of partial or conditional exemption (*).

†The Regulations in question are marked †; or in the case of partial or conditional exemption (†).

‡The Regulations in question are marked ‡; or in case of partial or conditional exemption (‡).

1. Age and sex.

(a) No woman, young person, or child shall be employed in the following processes:

‡(i) *Stopping of biscuit ware* with a material which yields to dilute hydrochloric acid more than five per cent. of its dry weight of a soluble lead compound calculated as lead monoxide when determined in the manner described in the definition of *low solubility glaze*.

* (ii) weighing out, shovelling, or mixing of unfritted lead compounds in the preparation or manufacture of frits, glazes, or colours;

*†(iii) lawning of glaze, except where less than a quart of glaze is lawned at a time for the worker's own use;

‡(iv) preparation or weighing out of *flow material*;

(*) (†)(v) cleaning, as prescribed in Regulation 12, of floors of *potters' shops* or stoves or any place in which any process included in the Schedule is carried on;

* (vi) cleaning, as prescribed in Regulation 17, of boards used in the dipping house, dippers' drying room, ware cleaning room, or glost placing shop;

*†(vii) cleaning of mangles or any part thereof;

‡(viii) washing of saggars with a wash which yields to dilute hydrochloric acid more than five per cent. of its dry weight of a soluble lead compound calculated as lead monoxide when determined in the manner described in the definition of *low solubility glaze*.

(b) No young person or child, other than a male young person who wedges clay only for his own use, shall be employed in the *wedging of clay*; and no woman shall be so employed without a certificate of *permission to work*.

(c) No young person or child shall be employed in the carrying of clay, or other systematic carrying or lifting work, without a certificate of *permission to work*, specifying the maximum weight which he or she may carry; and no young person or child so employed shall be allowed to lift or carry any weight in excess of that named in the certificate. Provided that:

(i) No certificate shall permit the carrying of more than 30 pounds by anyone under 16 years of age; and

(ii) No girl under 16 years of age and no boy under 15 years of age shall be allowed to carry clay, except that such a worker who is working for himself or herself, and is not an attendant of another worker, shall be allowed to carry such clay as is to be used by himself or herself in making articles of *pottery*.

(d) No female shall be employed for more than seven days as a wheel-turner for a thrower, without a certificate of *permission to work*.

(e) No girl under 16 years of age shall be employed as a lathe treader.

*†(f) No young person or child shall be employed as a dipper.

*†(g) No girl under 17 years of age and no boy under 16 years of age shall be employed as a dipper's assistant or ware cleaner.

*†(h) No woman, young person, or child shall be employed as a glost placer, except in the placing of china furniture or electrical fittings; and no girl under 17 years of age and no boy under 16 years of age shall be employed as a glost placer in the placing of china furniture or electrical fittings. Except that male young persons over 16 years of age may be employed in the process of *glost placing* for the purpose of preparing saggars and assisting in the sagger-house during the drawing of ovens, provided that they shall not place any ware in the saggars.

* (k) In *low solubility glaze factories*:

(i) No person under 16 years of age shall be employed as a dipper;

(ii) No person under 15 years of age shall be employed as a dipper's assistant, ware cleaner, or glost placer.

(*) (†) (l) Except as provided in Regulation I (k) (ii), no person under 16 years of age shall be employed in any process included in Part I of the Schedule; and no person under 15 years of age shall be employed in any process included in Part II of the Schedule.

(m) No female shall carry a sagger full of ware; but

(i) the moving of such a sagger from one part of a bench to a contiguous part of the same bench on the same level; or

(ii) the moving of such a sagger by any two females from a bench to the nearest convenient floor space in the same workroom if no saggars so moved are piled to a greater height than four feet,

shall not be deemed to be a contravention of this requirement.

2. Periodical examinations.

(*) (†) (‡) (a) All persons employed in any process included in Part I of the Schedule shall be examined once in each calendar month by the *Surgeon*; and all persons employed in any process included in Part II of the Schedule shall be examined once in every twelve months by the *Surgeon*.

(b) All persons for whom certificates of *permission to work* are required by Regulation 1 shall be examined by the *Surgeon* within seven days of the commencement of their employment in a process in which such a certificate is required.

(c) All young persons and children employed in the carrying of clay, or other systematic carrying or lifting work, shall be re-examined by the *Surgeon* twice in the first period of six months, and once in each period of six months thereafter until they attain the age of 18.

(d) Any female examined for employment as a wheel-turner shall be presented for re-examination at a later date, if the *Surgeon* considers it necessary.

(*) (†) (‡) (e) The fees for all medical examinations made in pursuance of these Regulations shall be paid by the employer and shall not be charged to the worker, whether he be in regular or casual employment. Provided that casual workers examined at the *Surgeon's* surgery shall pay a fee of one shilling for each certificate entered in the portable register; this fee shall be refunded by the occupier who first employs the worker after such examination; and the occupier shall record in the portable register the fact that the fee has been refunded.

(*) (†) (‡) (f) A notice shall be affixed in a prominent place in the factory, showing clearly the time appointed for the *Surgeon's* periodical visit; and an amending notice shall be affixed forthwith if it is found necessary to alter the date or hour; wherever possible, not less than three days' notice of a change of date shall be given.

(*) (†) (‡) (g) A private room shall be provided for all medical examinations. No one shall be present, except such other medical man as the *Surgeon* may with the worker's consent admit; and in addition in the case of a female any one female relative may be present, or alternatively any one workwoman in the factory approved by the worker and the *Surgeon*.

(*) (†) (‡) (h) No person after *suspension* shall be allowed to work in any process in which examination by the *Surgeon* is required by these Regulations, without a certificate of *permission to work*.

3. Health, etc., Register.

(*) (†) (‡) (a) A register, in the form or forms prescribed, shall be kept, in which the *Surgeon* may enter the dates and results of his visits, the number of persons examined in pursuance of these Regulations, and particulars of any directions given by him. This register shall contain a correct list of all persons employed in the processes included in the Schedule, and of all persons for whom a certificate has been obtained in pursuance of Regulation 1; as well as all other particulars required to be entered in the register in pursuance of these Regulations.

(*) (†) (‡) (b) The register shall be open to the inspection of any worker so far as concerns the entries relating to that worker. All such entries as indicate the general health of the worker shall be so expressed as to be readily understood both by occupiers and persons employed.

(*) (†) (‡) (c) When a certificate of *suspension* or *permission to work* is sent by the *Surgeon* to the occupier, it shall be forthwith attached to the register, and shall be kept so attached until replaced by a personal entry by the *Surgeon* in the register.

4. Overalls and head-coverings.

(*) (‡) (a) The occupier shall provide and maintain suitable overalls and head-coverings for all persons employed in the processes included in the Schedule; except that head-coverings need not be provided for persons employed in *majolica painting* or *glost placing*.

(*) (‡) (b) Head-coverings shall be adequate to protect the hair from dust, and shall be worn in such manner as to be effective for this purpose.

(*) (c) The occupier shall provide and maintain suitable aprons of a waterproof or similar material which can be sponged daily, for all dippers, dippers' assistants, and ware cleaners; provided that, if the front of the overall supplied to any such worker in pursuance of these Regulations is made of a material which can be sponged daily, no separate apron need be provided for that worker.

(*) (‡) (d) No person shall be allowed to work in any process included in the Schedule without wearing the above-named overalls and head-coverings, as well as aprons when provided in pursuance of the preceding paragraph; except that head-coverings need not be worn by persons employed in *majolica painting* or *glost placing*.

(*) (e) All aprons made of waterproof or similar material, and all overalls or parts of overalls made of such material, shall be thoroughly cleaned daily by the wearers by sponging or other wet process. All other overalls or parts of overalls and all head-coverings shall be washed or renewed at least once a week; and the occupier shall provide for washing, renewal, and necessary

repairs of all overalls and head-coverings to be done either at the factory or at a laundry; and no worker shall be allowed to take home any overalls, head-coverings or aprons provided in pursuance of these Regulations.

(*) (†) (f) All overalls, head-coverings, and aprons provided in pursuance of these Regulations, when not in use or being washed and repaired, shall be kept in proper custody; for this purpose there shall be provided a cupboard or cupboards or room or rooms suitably situated and sufficiently large to hold the overalls, head-coverings, and aprons; a separate peg shall be provided for each worker who is required by these Regulations to wear overalls.

5. Outdoor clothing.

(*) (†) (a) A cupboard or cupboards or room or rooms shall be provided for workers to deposit clothing put off during working hours; the accommodation provided for this purpose shall be sufficient to hold the outdoor clothing of all workers who are required by these Regulations to wear overalls, and a separate peg shall be provided for each such worker; all such cupboards or rooms shall be entirely separated from any source of lead or other dust, and from any place provided for the keeping of overalls, head-coverings, or aprons, and shall be kept thoroughly clean by the occupier.

(*) (†) (b) The occupier shall make adequate provision for drying such outdoor clothing, if wet, during the time it is put off in working hours; this provision shall not be made in any place where there is any source of lead or other dust, or in any place provided for the keeping of overalls, head-coverings, or aprons, or in any mess-room provided in pursuance of these Regulations, unless such provision consists of cupboards arranged against the wall and ventilated directly to the outside air, in which case the space occupied by such cupboards shall be deemed to be part of the mess-room accommodation, and the provision shall be subject to the approval of the Inspector of Factories for the district.

6. Food.

(*) (†) (a) No person shall be allowed to keep, or prepare, or partake of any food, drink, or tobacco, or to remain during meal-times in any place in which is carried on any process included in the Schedule, or the process of towing, or the process of tile-making by the compression of dust, or any other process which the Inspector of Factories for the district shall certify as sufficiently dusty to render the room in which it is carried on an unsuitable place, in his opinion, for persons to remain during meal-times.

(*) (†) (b) Mess-room accommodation shall be provided for the workers employed in the processes included in the Schedule, and for such others as are excluded from their own workrooms during meal-times in pursuance of paragraph (a) of this Regulation.

(*) (†) (c) This accommodation shall consist of a clean, well-ventilated, and well-lighted room or rooms in which no manufacturing process is carried on; it shall be at or near the factory, and shall be sufficiently large to accommodate all the workers employed in the processes included in the Schedule, and all others who are excluded from their own workrooms during meal-times in pursuance of paragraph (a) of this Regulation, allowing floor space in accordance with the following scale:

In mess-rooms for

6 persons and under.....	10½ sq. ft. per person.
Over 6 persons and up to 12.....	7½ " " "
" 12 " " 20.....	6 " " "
" 20 " " 28.....	5½ " " "
" 28 " " any number.....	5 " " "

(*) (†) (d) Provided that if the Inspector of Factories for the district shall certify that in his opinion the special circumstances of any factory are such as to render the provision of mess-room accommodation for all such workers unnecessary, it shall be sufficient to provide accommodation, calculated on the above scale, for such a proportion of all such workers as is named on the certificate of the Inspector; but in no case shall this proportion be less than one-third, subject, in cases of difficulty, to appeal to H.M. Chief Inspector of Factories; and the Inspector for the district shall have the right, at any time, to cancel or amend any such certificate.

(*) (†) (e) All mess-rooms provided in pursuance of this Regulation shall be furnished with proper tables and seats; provision shall be made for maintaining a proper temperature not below 55 degrees Fahrenheit; and all mess-rooms shall be thoroughly cleaned daily at the occupier's expense.

(*) (†) (f) No person shall be allowed to take into a mess-room any overall, head-covering, or apron worn in a process included in the Schedule.

(*) (†) (g) The washing conveniences prescribed by the Regulations shall not be maintained in any mess-room.

(*) (†) (h) A suitable place for the deposit of food shall be provided for each worker using the mess-room. Such provision shall not be made in a room in which any manufacturing process is carried on, and shall be subject, in each case, to the approval of the Inspector of Factories for the district.

(*) (†) (i) Adequate facilities shall be provided to enable workpeople to heat their food.

(*) (†) (l) A supply of milk, or cocoa made with milk, shall be provided for all women and young persons working in processes included in Part I of the Schedule, who commence work

before 9 a.m. Not less than half a pint shall be provided for each such worker at the expense of the occupier.

7. *Suppression of dust.*

(a) The following processes shall not be carried on without the use of an efficient exhaust draught:

- ‡(i) The fettling of flat ware, whether china or earthenware, by towing or sandpapering, provided that this shall not apply to the occasional finishing of pieces of china or earthenware without the aid of mechanical power;
- ‡(ii) The sand-sticking of sanitary ware;
- ‡(iii) Any other process of fettling on a wheel driven by mechanical power, except where:
 - (a) the fettler is fettling, as an occasional operation only, ware of his or her own making; or
 - (b) The fettling is done wholly with a wet sponge or other moist material; or
 - (c) the fettling is done by the worker who has made the articles, whilst the latter are still in a moist state.
- ‡(iv) The sifting of clay dust for making tiles or other articles by pressure, except where:
 - (a) this is done in a machine so enclosed as effectually to prevent the escape of dust; or
 - (b) the material to be sifted is so damp that no dust can be given off.
- ‡(v) The pressure of tiles from clay dust, an exhaust opening being connected with each press; this clause shall also apply to the pressing from clay dust of articles other than tiles, unless the material is so damp that no dust is given off.
- ‡(vi) The fettling of tiles made from clay dust by pressure, except where the fettling is done wholly on or with damp material; this clause shall also apply to the fettling of other articles made from clay dust, unless the material is so damp that no dust is given off.
- ‡(vii) The processes of *bedding* and *flinting*.
- ‡(viii) The brushing of earthenware biscuit, unless the process is carried on in a room provided with efficient general mechanical ventilation or other ventilation which is certified by the Inspector of Factories for the district as adequate, having regard to all the circumstances of the case.
- ‡(ix) *Scouring* of biscuit ware which has been fired in powdered flint, except where this is done in machines so enclosed as effectually to prevent the escape of dust.
- ‡(x) *Batting* of biscuit ware which has been fired in powdered flint.
- ‡(xi) Glaze blowing.
- *‡(xii) Ware cleaning after the application of glaze by dipping or other process, except as set forth later in this Regulation.
- ‡(xiii) The preparation of weighing out of *flow material* which yields to dilute hydrochloric acid more than five per cent. of its dry weight of a soluble lead compound calculated as lead monoxide when determined in the manner described in the definition of *low solubility glaze*.
- ‡(xiv) The lawning of dry colours, except where not more than an ounce at a time is lawned for use in painting.
- ‡(xv) Ground laying, including the wiping off of colour after its application to the surface of the ware.
- ‡(xvi) Colour dusting, whether under-glaze or on-glaze, including the wiping off of colour after its application to the surface of the ware.
- ‡(xvii) Colour blowing or aerographing, whether under-glaze or on-glaze, including the wiping off of colour after its application to the surface of the ware.
- ‡(xviii) The making of lithographic transfers, including the wiping off of colour after its application to the surface of the transfer sheets.

(b) In the process of mould-making, every bin or similar receptacle used for holding plaster of Paris shall be provided with an *efficient exhaust draught* so arranged as to prevent the escape of plaster of Paris dust into the air of the workplace; except where a cover is provided for the bin or other receptacle, and the plaster of Paris is conveyed in a sack, the mouth of which is tied and only loosened after it has been placed in the bin or other receptacle.

(c) The dry grinding of materials for pottery bodies shall be done either with an *efficient exhaust draught* for the removal of dust, or in machines so enclosed as effectually to prevent the escape of dust; except that it shall not be deemed necessary in pursuance of this Regulation to provide an exhaust draught to remove small amounts of dust given off at the hopper of an enclosed machine in the course of feeding the same, if an outlet into an exhaust duct or to the outside air is fitted to the receptacle into which the powdered material is delivered.

(d) In the process of sand-sticking of sanitary ware, suitable provision shall be made for collecting any material which falls on the floor.

‡(e) In the process of making tiles from clay dust by pressure, supplies of material shall be conveyed to the work benches in such a manner as to disperse as little dust as possible into the air; clay dust shall not be carried into any press shop in sacks except where hoppers or similar receptacles are provided for receiving the clay dust; in which case a sack in sound repair shall

be used and the mouth of the sack shall be tied and only loosened after it has been placed in the hopper or other receptacle, which shall be provided with a cover. This clause shall also apply to the making of clay dust of articles other than tiles, unless the material is so damp that no dust is given off.

‡(f) After one year from the date on which these Regulations come into force, biscuit flat ware which has been bedded from firing shall not be removed from the saggars after firing, except at a bench fitted with an efficient exhaust appliance for the removal of dust.

‡(g) Flat-knocking and fired-flint-sifting shall be carried on only in enclosed receptacles, which shall be connected with an *efficient exhaust draught* unless so contrived as to prevent effectually the escape of dust.

*(h) In the process of ware cleaning of earthenware after the application of glaze by dipping or other process, wherever it is practicable to use damp sponges or other damp materials they shall be provided in addition to the knife or other instrument, and shall be used.

*(k) Nothing in these Regulations shall render it compulsory to provide an exhaust draught for ware cleaning if this process is carried on entirely with the use of wet materials; or if the ware cleaning be done within 15 minutes after the moment when the glaze was applied; but an *efficient exhaust draught* shall always be provided and used if any dry materials or implements such as knives or scrapers are used after the glaze is dry or more than 15 minutes after the moment when the glaze was applied.

*(l) In the process of ware cleaning, after the application of glaze by dipping or other process, sufficient arrangements shall be made for any glaze scraped off, which is not removed by the exhaust draught, to fall into water. All water troughs or other receptacles provided in pursuance of this clause shall be cleaned out and supplied with fresh water as often as necessary, and in no case less often than once a week; and no scrapings of glaze shall be allowed to collect in a dry condition on the sides of the water receptacle. Where grids or gratings are fitted over the water trough or other receptacle named in the foregoing paragraph, they shall be kept clean by repeated sponging or wiping with wet material during the time that the process of ware cleaning is being carried on. No boards or other articles shall be placed, even temporarily, on any such water trough, in such a way as to interfere with the efficient use of the trough.

(m) In all processes the occupier shall, as far as practicable, adopt efficient measures for the removal of dust and for the prevention of any injurious effects arising therefrom.

(n) Every process for which an exhaust draught is prescribed shall be carried on inside a hood or exhaust funnel; provided that, where the occupier can show that this is impracticable, it shall be sufficient if the work is done within the effective range of an exhaust opening.

8. Respirators.

(a) No person shall be allowed to work without wearing a suitable and efficient respirator, such as a damp sponge tied across the mouth and nostrils, in any of the following processes:

(i) The emptying of sacks of plaster of Paris into a bin in a mould-making shop;

*(ii) the weighing out, and shovelling, or mixing of unfritted lead compounds, in the preparation or manufacture of frits, glazes or colours containing lead, or any process carried on in a room wherein any such weighing out, shovelling, or mixing has taken place within the previous thirty minutes;

unless an *efficient exhaust draught* is provided to prevent the escape of dust into the air of the workplace.

(b) All respirators required by this Regulation shall be provided and maintained in a cleanly state by the occupier; and each respirator shall bear the distinguishing mark of the worker to whom it is supplied.

9. Ventilation.

‡(a) Every place in which any worker or workers are employed shall be thoroughly ventilated.

‡(b) All workrooms in which articles are left to dry shall be ventilated in such a way as to insure a continuous movement of the air in the room in a direction away from the workers and towards the articles in question.

‡(c) All drying stoves shall be ventilated direct to the outside air by shafts having upward inclinations and terminating vertically, or by louvres in the roof, or by other effective means.

‡(d) All mangles shall be so ventilated as to provide for the maintenance of a flow of air into the hot chamber from the adjoining workroom.

In the case of vertical or "tower" mangles:

(i) the pipes for heating the mangle shall be fixed above the top of any opening at which workers put in or take off wares; and

(ii) there shall be a free outlet into the air above, so formed and placed as to insure an outflow whatever the direction of the wind.

‡(e) Fresh air shall, where practicable, be admitted to all workrooms by inlets placed along the sides of the room at a height of as nearly as possible 6 feet above the floor level, hopper opening being used for the purpose wherever possible.

‡(f) Where it is not practicable to provide such fresh air inlets, arrangements shall be made for the entry of an adequate amount of pure air by a flue with apertures at intervals along its length, or other means, which will secure an even distribution of the air through the room.

‡(g) In no case shall fresh air inlets be so arranged that a draught can blow directly from them on to any worker.

‡(h) Wherever the natural air currents are found to be insufficient without assistance to afford thorough ventilation, exhaust fans or other artificial means of creating a current of air shall be provided and maintained in use.

‡(k) Where an exhaust draught is provided for the removal of dust generated in a manufacturing process, precautions shall be taken to prevent dust being drawn into the general atmosphere of the room from other sources of dust in places in the vicinity; communication with such places shall be stopped wherever possible, and the fresh air inlets hereinbefore mentioned shall be so arranged as to insure that no extraneous dust is drawn towards the workers by the exhaust draught.

10. *Temperature.*

‡(a) Such a condition of the atmosphere shall be maintained in all *workrooms* that the reading of the wet bulb thermometer shall not exceed 70 degrees Fahrenheit, except at such times as the reading of the wet-bulb thermometer in the shade in the open air exceeds 65 degrees Fahrenheit.

‡(b) A thermometer, suitably mounted for observing the wet-bulb reading, shall be provided in every *workroom* in which any articles are allowed to dry, or in connection with which artificial heat is used in aid of the manufacturing process, whether in the *workroom* itself or in drying stoves or mangles or other appliances adjoining the *workroom*.

‡(c) Wherever steam or hot water pipes pass through a *workroom*, they shall be efficiently protected, and if not used for the purpose of heating that room, they shall be efficiently covered with non-conducting material.

‡(d) The following Regulations shall apply to the drawing of ovens:

(i) The temperature, whether taken at the bottom of the stage where the top drawer stands, or at any lower stage where men are working, shall not exceed 125 degrees Fahrenheit at any time when men are working in the oven;

(ii) Except that, in the case of any oven in which

(a) cooling dampers are in use, and in respect of which

(b) there has been no unnecessary delay in setting in the oven,

it shall be permissible, on the joint agreement of employer and employed, to suspend the above rule not more than four times in any period of twelve months; but such suspension of the rule shall be conditional on immediate notice being sent to the Inspector of Factories for the district, stating the name or number of the oven which is being drawn at a temperature exceeding 125 degrees Fahrenheit, taken as above. For the purpose of this exception, every oven to which it applies shall be given a distinctive name or number which shall be recorded in the register. Particulars of any notice sent to the Inspector of Factories for the district in pursuance of this exception shall also be recorded in the register.

(iii) When notice is given by the oven-men, whether verbally to the manager or occupier, or by handing in a written notice at the office before 5.30 p.m., to the effect that the oven-men wish to have the temperature tested before the oven is drawn next day, arrangements shall be made for a responsible representative of the occupier to be present for the purpose at the time when the drawing in question commences.

(iv) The temperature of ovens shall also be taken on a demand being made by the oven-men at any time when they are engaged in drawing.

11. *Lavatories.*

(*)‡(a) The occupier shall provide and continually maintain for the use of all persons employed in processes named in the Schedule, at least one lavatory basin for every five such persons. Each such basin shall be provided with a waste pipe and plug, or the basins shall be placed in a trough fitted with a waste pipe. There shall be a constant supply of hot and cold water laid on to each basin.

(*)‡(b) Or, in the place of basins, the occupier shall provide and maintain troughs of enamel or similar smooth impervious material, in good repair, of a total length of at least two feet for every five persons employed, fitted with waste pipes, and without plugs, with a sufficient supply of warm water constantly available from taps or jets above the trough at intervals of not more than two feet. Provided that if the Inspector of Factories for the district certifies that in his opinion it is not reasonably practicable for hot or warm water to be laid on to the lavatories in any factory or in any part of a factory, it shall be deemed to be sufficient if an adequate supply of hot water is provided as near as practicable to such lavatories. The Inspector of Factories for the district shall have the right at any time to cancel or amend any such certificate.

(*)‡(c) The lavatory shall be kept thoroughly cleaned at the cost of the occupier.

(*)‡(d) Before each meal and before the end of the day's work, at least ten minutes, in addition to the regular meal-times, shall be allowed for washing to each such person, provided that if the lavatory accommodation specially reserved for such persons exceeds that required by the preceding paragraphs, the time allowance may be proportionately reduced, and that if there be one basin or two feet of trough for each such person, no allowance of time shall be required.

(*)†(e) The lavatories shall be under cover and shall be fitted up as near as practicable to the places in which the workers for whom they are provided are employed.

(*)†(f) There shall be in front of each washing basin, or trough, a space for standing room which shall not be less in any direction than 21 inches.

(*)†(g) Sufficient space shall be provided under cover in or adjoining the lavatory for such workers as use the lavatory while awaiting their turn to wash.

(*)†(h) One roller towel, fastened in position, at least 15 square feet in area, shall be provided for every three workers, and shall be washed or renewed daily.

(*)†(k) Or, one roller towel, fastened in position, at least 15 square feet in area, shall be provided for every nine workers and shall be washed or renewed after every meal-time and at the close of the day's work.

(*)†(l) Or, a towel at least 5 square feet in area shall be provided for each worker, and shall be washed or renewed daily; in this case a peg with the worker's name shall be provided for each towel.

(*)†(m) One nail brush shall be provided for each basin or every two feet of trough, and shall be maintained in a cleanly and efficient condition. If fastened down, it shall be taken up once a week, and cleaned or renewed.

(*)†(n) A sufficient supply of soap shall always be available at each basin, or every two feet of trough.

(*)†(o) Separate lavatories for males and females shall be provided. An adjustable wooden partition across a lavatory shall be deemed to be sufficient separation, provided that it ensures complete privacy for females while washing.

12. Floors.

(a) The floors of all slip-houses shall be kept thoroughly clean.

(b) In all *pottery shops*, including such drying stoves as are entered by workpeople, and in all places where the following processes are carried on, viz.:

*Making or mixing of frits, glazes, or colours containing lead.

*†Application of majolica, or other glaze, by blowing, painting or any other process except dipping,

Preparation, or weighing out, of *flow material*,

Ground laying, including the wiping off of colour after this process,

Colour dusting, } whether on-glaze or under-glaze, including the wiping off of

Colour blowing, } colour after either of these processes,

Colour grinding for colour blowers,

Lithographic transfer making,

the following Regulations shall apply:

(i) There shall be provided and maintained:

(a) either impervious floors;

(b) or wooden floors with a thoroughly smooth and sound surface, constructed in such a substantial manner as to be free from permanent sag, and maintained in such repair that they can be properly cleaned by a moist method, and that no dust can fall through into rooms below.

(ii) The floors, when the rooms are in use, shall be thoroughly cleaned daily, by a moist method, by an adult male after work has ceased for the day, and before 3 a.m. next morning; except that in rooms in which ground laying is done, the cleaning prescribed by this Regulation may be done before work commences in the morning, provided that in no case shall any work be carried on in the room within one hour after such cleaning as aforesaid has ceased.

(iii) Scraps of clay and other debris, including any which have collected under benches, shall not be allowed to accumulate unduly, and all such scraps and debris shall be carried out at least once a day. Scraps of clay in *pottery shops* shall be damped before being carried out.

In all drying stoves which are entered by workpeople, boxes shall be provided for the reception of broken or waste clay ware.

(iv) Suitable provisions shall be made for the storage of all moulds when not in use.

In existing installations, the tops of drying stoves shall not be used for this purpose unless it is shown to the satisfaction of the Inspector of Factories for the district that no other suitable place is available. In any new erections, suitable provisions shall be made without utilizing the tops of stoves for this purpose, unless the top of the stove is made into a separate chamber.

†(c) The floors of all biscuit placing and glost placing shops shall be impervious, even floors, of brick, flag or similar hard material, and shall be kept in good repair; they shall be thoroughly sprinkled and swept by an adult male whenever the work of setting in an oven has ceased, and under any circumstances at least once a day.

*††(d) The floors of all dipping houses, dippers' drying rooms, and ware cleaning rooms shall be washable, impervious floors, and shall be thoroughly cleaned daily by an adult male, after work has ceased for the day, with a sufficient supply of water and a mop or similar implement; provided that, in the case of china dippers' drying rooms, this cleaning may be done before work commences in the morning, instead of after work has ceased for the day.

The floors of all dipping houses, dippers' drying rooms, and ware cleaning rooms erected after the date on which these Regulations come into force shall be properly sloped towards a drain.

‡(e) In any new erection where steam pipes are used for heating a drying stove, dippers' drying room, or any place where articles are left to dry, the pipes shall, if possible, be fixed in the form of a rack of horizontal pipes in a vertical plane. Where this is impossible, the pipes shall be fixed in such a position as to allow a thorough cleaning under and around them.

In existing installations, if it is impracticable to comply with the preceding paragraph, the steam pipes shall be enclosed in a box in such a manner as to permit of the thorough cleaning of all parts of the box in which persons may walk or stand, and adequate measures shall be taken to prevent dust escaping from within the box. Slides, drawers, trap-doors or other contrivances shall be provided wherever necessary to facilitate cleaning under pipes.

All stillages shall be so arranged as to allow the floor to be thoroughly cleaned underneath them.

(f) In all *workrooms* not specially mentioned in the foregoing paragraphs of this Regulation, the following Regulations shall apply:

All floors shall be maintained in such repair that they can be properly cleaned by a moist method, and shall be so cleaned daily.

All ashes, dirt or other debris, including any which have accumulated under benches, shall be carried out daily.

(g) The above requirement as to the daily cleaning of floors by a moist method shall not apply to places where saggars, retorts or crucibles are made, or to those parts of floors on or immediately above which articles of *pottery* are necessarily left overnight, if adequate provision is made for the cleaning of the floors as soon as the articles are removed.

13. *Work benches.*

The following Regulations shall apply to work benches in *potters' shops*, and in places where processes named in the Schedule are carried on:

(*)‡(a) Work benches, if not covered with sheet metal or constructed with an impervious surface, shall be strongly and solidly constructed of closely jointed timber, and the surface of the work benches shall be well maintained.

(*)‡(b) All work benches in use shall be thoroughly cleaned daily by a moist method.

14. *Lead house.*

*(a) Raw lead compounds shall not be handled except with at least 5 per cent. of added moisture.

*(b) They shall, further, be kept in their original packages until weighed out, and the tub or other receptacle containing them shall be so fitted either with a cover or a damp screen as to prevent the issue of any lead dust from its mouth.

‡(c) In every lead house, except such as are used for less than eight hours in any week, a special lavatory basin with a supply of hot and cold water, nail brush, soap and towel shall be provided and maintained; and a solution of soluble sulphides shall be provided in which workers in the lead house shall rinse their hands after washing so as to show if they are free from lead.

15. *Dipping house, etc.*

‡(a) In dipping houses, all parts of walls sufficiently near to any dipping tub to be splashed with glaze, shall be tiled, or painted with washable paint, or otherwise treated in such a manner as to permit of thorough cleaning by a wet process.

‡(b) The above-named parts of walls, as well as the dipping tubs and any other objects which are splashed with glaze, shall be thoroughly cleaned daily by a wet process.

(c) All dipping houses and ware cleaning rooms shall be well lighted; neither dipping nor ware cleaning shall be done in places which, in ordinary fine weather, are dependent on borrowed light or artificial light during the hours of daylight.

16. *Threading-up.*

‡‡In the process of threading-up, rubber or other washers, used to keep articles when being dipped, shall be thoroughly washed in a colander after each dipping. Wires shall also be washed after each dipping.

17. *Boards.*

*(a) Every board on which dipped ware has been placed shall, on each occasion after it has been used for one set of articles, and before being used for another, be thoroughly cleaned with clean water by an adult male.

*(b) "Nailed" or "pegged" boards shall be cleaned under a strong jet of water; no new boards of this description shall be introduced except where necessary to hold china furniture or other special articles which cannot be carried on ribbed or plain boards.

(*)‡(c) Boards for use in processes included in Part I of the Schedule shall be clearly marked by painting them in red at the ends and for a distance of at least six inches from each end of

the board on both sides, so as to distinguish them from other boards which do not come into contact with lead. Boards so marked shall not be used in any department unless they have been thoroughly cleaned, and shall not be used in the clay department under any circumstances. Boards not so marked shall not be taken into any place where a process included in Part I of the Schedule is carried on; but this shall not apply to placing shops in which both biscuit and glost ware are being placed, provided that the boards used for biscuit ware are kept separate and returned to their respective departments without any contact with the boards used for glost ware.

18. *Mangles.*

*†All mangle shelves shall be thoroughly cleaned by a wet process by an adult male on a fixed day in each week, after work has ceased for the day. The day on which this cleaning is to take place shall be fixed by entry in the register kept in pursuance of Regulation 3.

19. *Thimble picking.*

(*)††All material collected from floors or work benches shall be riddled in an enclosed receptacle before it is taken to a thimble picking room.

20. *Majolica painting.*

The following Regulations shall apply to the process of *majolica painting*—

- *†(a) A sponge and bowl of clean water, to rinse the fingers, shall be provided on the work bench beside each person employed in *majolica painting*.
- *†(b) In all *majolica painting* shops where there is no adjoining lavatory accommodation, there shall be provided in the room a lavatory sink with a tap, a constant supply of water, and towels.
- *†(c) All splashes of glaze falling on the benches, or surrounding objects, shall be immediately removed with a wet sponge or other wet material.
- *†(d) No floor or work bench shall be deemed to have been thoroughly cleaned, in accordance with Regulation 12 or 13, unless all splashes of glaze have been completely removed.
- *†(e) Mottling, or any similar method of applying glaze, shall only be carried on under the Regulations applying to *majolica painting*.
- *†(f) All cleaning and scraping, including panel-cutting, after *majolica* dipping, *painting*, or blowing, shall be deemed to be ware cleaning, and shall only be done in compliance with the rules for the latter process.

21. *Cotton-wool in ground laying, colour dusting, and lithographic transfer making.*

†All pieces of cotton-wool or similar materials which have been used in the process of ground laying or colour dusting, or lithographic transfer making, shall be kept in a proper receptacle. All pieces of waste cotton-wool or similar materials which have been so used shall be immediately burnt.

22. *Aerographing.*

†(a) No short-sighted person shall be employed to do glaze or colour blowing, unless wearing suitable glasses. No person shall be employed as a glaze or colour blower, unless the *Surgeon* has entered in the *health register* a certificate stating that he has examined the worker's sight and is satisfied that he or she can be so employed without breach of this Regulation.

†(b) All hoods in which the blowing of glaze or colour is carried on shall be thoroughly cleaned daily by a wet process.

†(c) Glaze or colour blowing shall not be done with the mouth.

†(d) Decoration on unfired clay ware by means of coloured clay slips shall not be regarded as lead blowing for the purposes of any of the Regulations applying specially to the latter process.

23. *Lithographic transfer making.*

†Machines used in lithographic transfer making shall not be brushed down, but shall be cleaned either

- (a) with moist materials, such as oily rags, in such a manner as not to disperse any dust into the air; or
- (b) by means of an exhaust current of air, such as that afforded by a vacuum-cleaner.

24. *Separation of processes.*

(*)††(a) Thimble picking or threading-up shall not be carried on except in a place sufficiently separated from any process included in the Schedule.

(*)††(b) When a process included in the Schedule is being carried on in a room where other work is also done:

- (i) Either the place where the scheduled process is carried on shall be screened off from the rest of the room by a partition not less than eight feet high,
- (ii) or all persons working in the room shall be deemed to be persons employed in the scheduled process.

25. *Hours of employment.*

(a) No person employed in a process included in Part I of the Schedule, except in *glost placing* and lithographic transfer making, shall be employed for more than four hours without an interval of at least half an hour for a meal.

No person shall be employed in the process of *glost placing* or in the process of lithograph transfer making for more than 4½ hours, or in any other process for more than 5 hours, with an interval of at least half an hour for a meal.

(*) (i)(b) No woman or young person who is employed in any process included in Part I of the Schedule shall be employed in the factory in any capacity for more than 48 hours in any week.

(*) (c) No adult male who is employed as a dipper, dipper's assistant, or ware cleaner shall be employed in the factory in any capacity for more than 48 hours in any week, provided that where such an adult male worker has been employed in a process included in Part I of the Schedule, for not more than 8 hours in any one day or 30 hours in all in a week, he may be employed during the same week on work not involving contact with lead up to a limit of 54 hours for that week.

(*) (d) No adult male who is employed as a *glost placer* shall be employed in the factory in any capacity for more than 54 hours in any week.

(*) (e) Except that it shall be permissible to employ adult male dippers, dippers' assistants, ware cleaners, and *glost placers* overtime in addition to the prescribed weekly periods of 48 and 54 hours; provided that such overtime shall not, in any factory to which these Regulations apply, exceed 4 hours in any week, or 36 hours in any period of twelve months. The occupier shall enter in the prescribed register particulars of all such overtime, and shall also send notice, with the prescribed particulars, to the Inspector of Factories for the district, before eight o'clock in the evening of any day when a man is employed overtime in pursuance of this exception. An occupier who avails himself of this exception shall, if called upon, produce to the Inspector of Factories for the district evidence of press of orders or other circumstance rendering the overtime necessary.

Adult male dippers, ware cleaners, and *glost placers* may be employed, in addition to the above-named hours, as sitters-up with an oven after the termination of the period of employment on one day in the week and before the commencement of the period of employment on the next day; provided that no such worker shall be employed in any capacity within 12 hours of the cessation of the period of sitting-up.

(f) In *potters' shops*, and in any place where towing or any other dusty process is carried on, including any process for which a certificate by an Inspector of Factories has been given in pursuance of the first paragraph of Regulation 6, no women or young person shall be employed for more than 9½ hours in any day or for more than 6½ hours on Saturday.

(g) All the above weekly and daily periods shall be the maximum permissible periods of actual work, exclusive of meal-times.

26. *Affixing of Regulations.*

(*) (i) In addition to the printed copies of these Regulations required to be kept posted up in pursuance of Section 80 of The Factory and Workshop Act, 1901,¹ there shall be kept constantly affixed in every *potters' shop* and in every place in which any process included in the Schedule is carried on, a notice printed in bold type so that it can be easily read, setting forth those portions of the Regulations which apply to that particular work-place.

27. *Observance of Regulations.*

(a) A person or persons shall be appointed who shall see to the observance, throughout the factory, of the Regulations, and whose duty it shall be to carry out systematic inspection of the working of all the Regulations in the departments for which they are individually responsible. The names of the persons so appointed shall be recorded in the register.

(b) Each person so appointed shall be a competent person fully conversant with the meaning and application of the Regulations in so far as they concern the departments for which he is responsible. He shall keep in the factory a book in which he shall record any breach of the Regulations, or any failure of the apparatus (fans, etc.) needed for carrying out the provisions, that he may have observed, or that may have been brought to his notice within the preceding 24 hours, together with a statement of the steps then taken to remedy such defects or to prevent the recurrence of such breach. Each entry in such book shall be dated and initialled by the person appointed, who at the end of each week shall make a further entry stating that the inspection required by paragraph (a) has been carried out, and that all the defects observed or brought to his notice have been recorded in the book. Such book shall be kept in the factory for at least six months after the latest entry therein.

(c) Accurate extracts, clearly and legibly expressed, shall be made of these entries once a week, and signed by the occupier or someone whom he may appoint, and displayed during the following week in a conspicuous place in the departments to which they refer, and copies of all such extracts shall for the same time be displayed in a conspicuous place in the mess-rooms.

28. *Samples for analysis.*

(a) The occupier shall allow any of His Majesty's Inspectors of Factories to take at any time sufficient samples for analysis of any material in use or mixed for use.

(b) Provided that the occupier may at the time when the sample is taken, and on providing the necessary appliances, require the Inspector to take, seal and deliver to him a duplicate sample.

(c) But no analytical result shall be disclosed or published in any way except such as shall be necessary to establish a breach of these Regulations.

PART II.

DUTIES OF PERSONS EMPLOYED.

29. *Periodical examinations.*

(*)(†)(a) All persons employed in the processes included in the Schedule shall present themselves at the appointed times for examination by the *Surgeon* as provided in Regulation 2.

(*)(†)(b) No person after *suspension* shall work in any process in which examination by the *Surgeon* is required by those Regulations without a certificate of *permission to work*.

30. *Overalls, etc.*

(*)(†)(a) All persons employed in any process included in the Schedule shall, when at work, wear overalls, head-coverings, and aprons, as required by Regulation 4. The said overalls, head-coverings, and aprons, shall not be worn outside the factory or workshop, and shall not be removed therefrom except for the purpose of being washed or repaired. No overalls, head-coverings or aprons, provided in pursuance of Regulation 4, shall, under any circumstances, be taken to a worker's home.

(*)(†)(b) The head-coverings provided in accordance with Regulation 4 shall be worn in such a manner as effectually to protect the hair from dust, and the hair must be so arranged as to permit of this.

(*)(†)(c) The overalls, head-coverings, and aprons, when not being worn, and clothing put off during working hours, shall be deposited in the respective places provided by the occupier for such purposes under these Regulations.

(d) Respirators shall be worn as required by Regulation 8.

31. *Food.*

(*)(†)(a) No person shall introduce, keep, prepare, or partake of any food, drink, or tobacco, or remain during meal-times in any place in which is carried on any process included in the Schedule, or the process of tanning, or the process of tile-making by the compression of dust, or any other process which the Inspector of Factories for the district shall certify as sufficiently dusty to render the room in which it is carried on an unsuitable place, in his opinion, for persons to remain during meal-times.

(*)(†)(b) Every worker for whom milk or cocoa is provided in accordance with Regulation 6 shall drink the same, unless a medical certificate is produced showing cause for exemption from this requirement.

32. *Ventilation—Dust.*

No person shall in any way interfere, without the knowledge and concurrence of the occupier or manager, with the means and appliances provided by the employers for ventilation, and for the removal of dust.

33. *Washing.*

(*)(†)(a) No person employed in any process included in the Schedule shall leave the works or partake of meals without previously and carefully cleaning and washing his or her hands.

(*)(†)(b) No person employed shall remove or damage the washing basins or conveniences provided under these Regulations.

34. *Cleaning of work places.*

The persons appointed by the occupiers shall clean the several floors, walls, work benches, appliances and other objects regularly as prescribed in these Regulations.

35. *Boards.*

(a) The boards used in the dipping house, dippers' drying room, or glost placing shop shall not be used in any other department, except after being cleaned, as directed in Regulation 17.

(b) No board on which dipped ware has been placed shall be used for a second set of dipped articles until it has been thoroughly cleaned in accordance with Regulation 17.

Where a convenient grid or other suitable contrivance is provided for depositing such boards after use and before being cleaned, the worker who has removed the ware from any such board shall place the board thereon.

**(c)* Boards which are marked for use in lead processes shall not be used in any department unless they have been thoroughly cleaned, and shall not be used in the clay departments under any circumstances.

36. *Avoidance of dust, etc.*

Every worker shall so conduct his or her work as to comply strictly with these Regulations, and to avoid, as far as practicable, making or scattering dust, or refuse, or causing accumulation of such.

R. McKENNA,
*One of His Majesty's Principal
Secretaries of State.*

Home Office, Whitehall,
2nd January, 1913.

SCHEDULE.

Part I.—Lead Processes.

**(a)* Making or mixing of frits, glazes, or colours containing lead.

**(b)* Dipping or other process carried on in the dipping house.

**(c)* Application of majolica, or other glaze, by blowing, painting or any other process except dipping.

**(d)* Drying after the application of glaze by dipping, blowing, painting, or other process.

**(e)* Ware cleaning after the application of glaze by dipping, blowing, painting, or other process.

**(f)* Placing of ware on cranks or similar articles prior to their transfer to saggars or kilns for the glost firing.

**(g)* *Glost placing.*

†*(h)* Washing of saggars with a wash which yields to dilute hydrochloric acid more than five per cent. of its dry weight of a soluble lead compound calculated as lead monoxide when determined in the manner described in the definition of *low solubility glaze*.

†*(k)* Preparation, or weighing-out, of *flow material*.

†*(l)* Ground laying, including the wiping off of colour after this process.

†*(m)* Colour dusting } whether on-glaze or under-glaze, including the wiping off of colour

†*(n)* Colour blowing } after either of these processes.

†*(o)* Colour grinding for colour blowers.

†*(p)* Lithographic transfer making.

**(q)* Any other process in which materials containing lead are used or handled in the dry state, or in the form of spray, or in suspension in liquid other than oil or similar medium, provided that the *stopping of biscuit ware* with a material containing lead shall not be deemed to be a process included in this Schedule.

Part II.—Other processes.

†*(r)* *Scouring* of biscuit ware which has been fired in powdered flint.

†*(s)* Emptying of biscuit ware which has been fired in powdered flint, from the baskets or other receptacles in which it has been conveyed to the biscuit warehouse or scouring shop.

(10) For the manufacture of certain compounds of lead; namely, any carbonate, sulphate, nitrate, or acetate of lead.

1921

REGULATIONS, dated August 23, 1921, made by the Secretary of State under Section 79 of The Factory and Workshop Act, 1901 (1 Edw. 7, c. 22), for the Manufacture of certain Compounds of Lead, namely, any Carbonate, Sulphate, Nitrate or Acetate of Lead.

In pursuance of Section 79 of The Factory and Workshop Act, 1901, I hereby make the following Regulations, and direct that they shall apply to all factories and workshops or parts thereof (other than laboratories) in which is carried on

The Manufacture of certain Compounds of Lead, namely, any Carbonate, Sulphate, Nitrate or Acetate of Lead.

These Regulations shall come into force on 1st October, 1921.

Definitions.¹

In these Regulations:

"*Lead compounds*" means any carbonate, sulphate, nitrate or acetate of lead, or any lead material used in the manufacture of such compounds and containing 5 per cent. or more of lead but excluding metallic lead or ores which contain lead only in the form of sulphide.

¹ Terms to which defined meanings are given are printed throughout the Regulations in italics.

"*Lead process*" means

- (i) manipulation, movement or other treatment of *lead compounds* involving exposure thereto, and
- (ii) cleaning, repairing or demolition of any part of any building or plant which has contained *lead compounds*, or reconstruction of any such building or plant with material which has formed part thereof.

"*Damp*" means sufficiently moist to allay dust.

"*Surgeon*" means the Certifying Factory Surgeon of the district or a duly qualified medical practitioner appointed by written certificate of the Chief Inspector of Factories, which appointment shall be subject to such conditions as may be specified in that certificate.

"*Suspension*" means suspension from employment in any *lead process* by written certificate in the Health Register, signed by the *Surgeon*, who shall have power of *suspension* as regards all persons employed in any *lead process*.

"*Approved*" means approved in writing by the Chief Inspector of Factories. Any such approval may at any time be revoked by notice in writing signed by the Chief Inspector of Factories.

Duties.

It shall be the duty of the occupier to observe Part I of these Regulations.

It shall be the duty of every person employed to observe Part II of these Regulations.

PART I.

DUTIES OF OCCUPIERS.

1.—(a) Where white lead is made by the "stack" process every stack shall be provided with a standpipe and movable hose, and an adequate supply of water distributed by a rose.

(b) Every white bed shall, on the removal of the covering boards, be effectually *damped* by the means mentioned above.

2. Where white lead is made by the "chamber" process, the chamber shall be kept *damp* while the process is in operation, and the corrosions shall be effectually *damped* before the chamber is emptied.

3.—(a) Corrosions shall not be carried except in trays of impervious material.

(b) No person shall be allowed to carry on his head or shoulder a tray of corrosions which has been allowed to rest directly upon the corrosions, or upon any surface where there are any dry *lead compounds*.

(c) All corrosions before being put into the rollers or washbecks, shall be effectually *damped*, either by dipping the tray containing them in a trough of water or by some other approved method.

4. The floor round rollers and open vats and of any place where dry *lead compounds* are packed or manipulated, or where cooping of old casks which have previously contained *lead compounds* is carried on, shall be of smooth cement or other smooth impervious material, and shall be kept constantly *damp*.

5.—(a) Every stove which is entered for the purpose of emptying shall have a window, or windows, with a total area of not less than 8 square feet, made to open, and so placed as to admit of effectual through ventilation.

(b) In no stove shall bowls be placed on a rack which is more than 10 feet from the floor.

(c) Each bowl shall rest upon the rack and not upon another bowl.

(d) No stove shall be entered for the purpose of drawing until the temperature at a height of 5 feet from the floor has fallen either to 70 degrees Fahrenheit, or to a point not more than 10 degrees Fahrenheit above the temperature of the air outside.

(e) In drawing any stove or part of a stove there shall not be more than one stage or standing place above the level of the floor.

Provided that, if *approved*, any other means of securing effectual through ventilation of a stove may be adopted, notwithstanding paragraph (a) of this Regulation; and if *approved*, any other method of setting and drawing the stoves, which effectually prevents the inhalation of *lead compounds*, may be followed, notwithstanding paragraphs (b) and (c) of this Regulation.

6. No person shall be employed on more than two days in any week in drawing any internally heated stove which is entered for the purpose of emptying.

7. No dry *lead compounds* shall be deposited anywhere except in an enclosure or receptacle that is provided either with a cover or with efficient means for preventing the escape of dust from such *lead compounds* in any workroom.

8. The treatment or packing of dry *lead compounds* shall be done only under conditions which either

- (1) prevent the escape of dust from such compounds, or
- (2) secure the effectual removal of such dust at or as near as practicable to its point of origin.

9. Every lead melting pot shall be provided with a proper enclosure fitted with hinged or sliding doors on any openings necessary for manipulative purposes; and every such enclosure and every furnace used in connection with a *lead process* shall be provided with an efficient

exhaust draught for effectually preventing the escape from such enclosure or furnace of any dust or fume containing lead into any workroom.

10. No skimmings, dross or similar material containing lead shall be removed from the exhaust draught required by Regulation 9 unless in a suitable covered receptacle.

11. (a) Every person employed in a *lead process* shall be examined once a week (or at such other intervals as may be *approved*) by the *Surgeon*, who shall have power to order *suspension* from employment in any place or process.

(b) No person after such *suspension* shall be employed in a *lead process* without the written sanction of the *Surgeon*.

(c) A Health Register in an *approved* form shall be kept, and shall contain a list of all persons employed in *lead processes*.

12. The occupier shall provide and maintain sufficient and suitable overalls and head-coverings and clean respirators, and shall cause them to be worn as directed in Regulation 25.

At the end of every day's work they shall be collected and kept in proper custody in a suitable place set apart for the purpose.

They shall be thoroughly washed or renewed every week; and those which have been used in the stoves shall be washed or renewed daily.

13. The occupier shall provide and maintain for the use of all persons employed, and remaining on the premises during meal intervals, a suitable and adequate mess-room, which shall be furnished with

(a) sufficient tables and chairs or benches with back rests, and

(b) adequate means for warming food and boiling water.

The mess-room shall be sufficiently warmed for use during meal intervals.

14. The occupier shall provide and maintain for the use of all persons employed suitable accommodation for clothing put off during working hours, with adequate arrangements for drying the clothing if wet. The cloak-room shall be separate from the mess-room.

15. There shall be provided and maintained in a cleanly state and in good repair for the use of all persons employed in a *lead process*:

(a) a lavatory, under cover, with a sufficient supply of clean towels, renewed daily, and of soap and nail brushes, and with either:

(i) a trough with a smooth, impervious surface, fitted with a waste-pipe without plug, and of such length as to allow at least two feet for every five such persons employed at any one time, and having a constant supply of warm water from taps or jets above the trough at intervals of not more than two feet; or

(ii) at least one lavatory basin for every five such persons employed at any one time, fitted with a waste-pipe and plug, and having a constant supply of hot and cold water or warm water laid on; and

(b) sufficient and suitable bath accommodation (douche or other) with hot water laid on, unless the water supply provided under paragraph (a) is so arranged that a warm douche for the face, neck and arms can be taken.

There shall, in addition, be means of washing in close proximity to the workers of each department, if required by notice in writing from the Inspector in charge of the district.

There shall be facilities, to the satisfaction of the inspector in charge of the district, for the workers to wash out their mouths.

16. Before each meal, and before the end of the day's work, at least ten minutes in addition to the regular meal times, shall be allowed to each worker for washing.

A notice to this effect shall be affixed in each department.

17. The mess-room, cloak-rooms, baths, and sanitary conveniences shall be placed under the charge of a responsible person, and shall be kept clean.

18. The floor of each workroom in which a *lead process* is carried on shall be cleaned daily, after being thoroughly *damped*.

PART II.

DUTIES OF PERSONS EMPLOYED.

19. No person shall strip a white bed or empty a chamber unless such bed or chamber is effectually *damped* as required by Regulations I and 2.

20. No person shall carry corrosions, or put them into the rollers or washbecks, otherwise than as permitted by Regulation 3.

21. No person shall set or draw a stove otherwise than as permitted by Regulations 5 and 6.

22. No person shall deposit or pack dry *lead compounds* otherwise than as permitted by Regulations 7 and 8.

23. Every person employed in a *lead process* shall present himself at the appointed times for examination by the *Surgeon*, as provided in Regulation II.

24. No person, after *suspension* by the *Surgeon*, shall work in a *lead process* without his written sanction.

25.—(a) Every person engaged in

White beds,
Emptying chambers,
Rollers, washbecks or grinding,
Setting or drawing stoves,
Packing,
Paint mixing,
Handling dry *lead compounds*,

or in any work involving exposure to dust of any *lead compounds*, shall, while so occupied, wear an overall suit and head-covering;

(b) Every person engaged in

Emptying white beds,
Emptying chambers,
Dry grinding,
Packing of dry *lead compounds*,
Handling of dry *lead compounds*,

Entering a chamber used for the condensation or recovery of *lead compounds*.
shall, while so occupied, wear a respirator.

26. Every person engaged in any place or process named in Regulation 25 shall, before partaking of meals or leaving the premises, deposit his overalls and head-covering and respirator in the place appointed by the occupier for the purpose.

27. Each person employed in a *lead process* shall before partaking of food or leaving the premises, wash his face, neck and arms in the lavatory provided for the purpose, under Regulation 15, and where bath accommodation is provided, shall take a bath at the factory at least once a week.

28. No person employed in a *lead process* shall smoke or use tobacco in any form, or prepare or partake of food or drink, elsewhere than in the mess-room.

29. No person shall in any way interfere, without the knowledge and concurrence of the occupier or manager, with the means and appliances provided for the removal of dust.

E. SHORTT,

*One of His Majesty's Principal
Secretaries of State.*

Whitehall,
23rd August, 1921.

CHAPTER II

BRITISH DOMINIONS AND INDIA

With the exception of Canadian legislation, which is reviewed in detail, no special attempt has been made to cover the field further than has already been done in the British compilation¹ on the subject to which we are, with a few exceptions, indebted for the texts.

(1) Canada

Labour legislation in Canada comes under the jurisdiction of the Provincial Governments. No province has to date enacted any laws relating to lead trades as such. The Metalliferous Mines Inspection Acts of British Columbia and Nova Scotia not including any provisions directed against lead poisoning. The only lead trades for which specific regulations are included in the General Factory Acts are: *printing* in Alberta and British Columbia; *brass, iron and steel foundries*, in Nova Scotia; *foundries* in Quebec. In Quebec also the General Factory Act prohibits the employment of boys under 16 and girls under 18 in certain dangerous pursuits, among which are included white lead, paint (boxing and canning of), smelting and rolling of iron, brass, lead and zinc, can manufacturing (soldering of boxes), canning works (soldering of boxes).

The general Factory Acts of the different provinces contain various health provisions which, while not in most cases aimed at the prevention of lead poisoning, have a bearing thereon. The legislative position can be briefly seen from the table facing this page:

Compensation for lead poisoning in Canadian Provinces

Alberta, British Columbia, Manitoba, New Brunswick, Nova Scotia and Ontario allow under the respective Workmen's Compensation Acts compensation for "lead poisoning or its sequelæ" in "any process involving the use of lead or its preparations or compounds."

Quebec and Saskatchewan do not recognize occupational diseases in their Workmen's Compensation Acts.

Law requiring the reporting of occupational diseases

No province in Canada has any law requiring physicians to report cases of occupational disease.

(2) New Zealand

There appears to be no specific lead legislation in New Zealand. The general Factory Act (An Act to Consolidate and Amend Certain Enactments of the General Assembly relating to Factories) of 6.2.22 has various regulations touching the question of lead poisoning indirectly under the following heads:

Restrictions as to the age of boys or girls employed in certain factories (Article 27)

- (b) "A girl under 15 years of age shall not be employed as type-setter in any printing office."
- (f) "A boy under 18 years of age or a woman shall not be employed in any work in which there is carried on"

VII The making of white lead."

¹ Gilbert Stone, *Laws and Regulations relating to Lead Poisoning*, 1922, pp. 121-131.

	Special Regulations for Certain Lead Trades	General Prohibition of Injurious Work	Employment of Women and Children	Meals in Workrooms	Removal of Fumes and Vapours	Prevention of Dust	Respirators	Washrooms, Soap, etc.	Drinking Water
<p><i>Alberta:</i> "The Factories Act," 1917.</p>	<p><i>Printing:</i> "In printing offices where there are 3 or more type-setting machines (linotypes, intertypes, monotypes, monolines, and the like), the melting pots of all type-setting, type-casting and similar machines, monotype casters, stereotype melting pots, and the like, shall be piped in a proper and efficient manner, so as to effectually carry off the noxious fumes and gases arising during their operation; and all melting pots of stereotyping and type-casting devices shall be properly provided with hoods extending over the melting pots and connected with the aforesaid piping in such manner as to carry off the fumes from the molten metal as well as the burned gas fumes; provided, that exhaust fans, blowers, or other suitable devices shall in such factories as the inspector orders also be installed for the purposes of further aiding in the discharge of all deleterious matter from composing and other rooms where any of the above machines may be in operation."</p> <p>(Article 31 (h).)</p>	<p>"No person shall keep a factory, shop or office so that . . . the health of the persons employed therein is likely to be injured."</p> <p>(Article 55.)</p>		<p>The eating of meals in any room where any manufacturing process is carried on shall be prohibited "if the inspector so directs."</p> <p>(Article 28 (a).)</p> <p>"No person shall take . . . food into any room where paint . . . dye, white lead . . . or any other poisonous substance is exposed or where deleterious fumes, dust or gases are known to be present, and drinking water in any such room shall be taken directly from taps or suitably closed receptacles."</p> <p>(Article 28 (c).)</p>	<p>Employers shall "ventilate the factory or shop in such a way as to keep the air reasonably pure and so as to render harmless, as far as reasonably practicable, all gases, vapours, dust or other impurities generated in the course of any manufacturing process or handicraft carried on therein that may be injurious to health."</p> <p>(Article 31 (d).)</p>	<p>"In every factory or shop where any process is carried on by which dust is generated and is inhaled by the workers to an injurious extent, then, subject to the regulations, the inspector may, if such inhalation can by mechanical means be prevented or partially prevented, direct that such means shall be provided within a reasonable time by the employer who shall be bound to provide them."</p> <p>(Article 31 (h) (3).)</p>		<p>Wash-room, clean towels, soap, and in foundries, shower baths.</p> <p>(Article 31 (f).)</p>	<p>Sufficient supply of wholesome drinking water and proper drinking cups.</p> <p>(Article 31 (f).)</p> <p>In rooms where deleterious fumes, dust or gases are known to be present, drinking water shall be taken directly from taps or suitably closed receptacles.</p> <p>(Article 28 (c).)</p>
<p><i>British Columbia:</i> "The Factories Act," 1911.</p>	Substantially the same as Alberta.	Substantially the same as Alberta. (Article 31.)	<p>"It shall not be lawful to employ in a factory any young girl or woman so that . . . (her) health is likely to be permanently injured."</p> <p>(Article 11.)</p>	Young girls and women prohibited from taking meals in any room where any manufacturing process is going on "if the inspector so directs." <p>(Article 12 (c).)</p>	Substantially the same as Alberta. (Article 23.)	Substantially the same as Alberta. (Article 27.)			
<p><i>Manitoba:</i> "The Manitoba Factories Act," 1913.</p>		Substantially the same as Alberta. (Article 32.)	<p>The same as British Columbia. Article 12.</p> <p>Also, employment of girls under 18 and boys under 16 in work deemed "dangerous or unwholesome may be prohibited."</p> <p>(Article 7.)</p>	Same as British Columbia. (Article 13 (c).)	Substantially the same as Alberta. (Article 24.)	Substantially the same as Alberta. (Article 28.)			
<p><i>New Brunswick:</i> "The New Brunswick Factories Act," 1919. Also Public Health Act, 1918.</p>		<p>The Minister of Health may . . . make . . . rules and regulations respecting any particular industry and the conditions under which the same can be carried on, for the purpose of preventing nuisance or the outbreak or spread of disease.</p> <p>Public Health Act, 1918, (Article 8 (p).)</p>	<p>Employment of girls under 18 and boys under 16 in work deemed "dangerous or unwholesome" may be prohibited.</p> <p>(New Brunswick Factory Act, 1919, Article 3.)</p>						
<p><i>Nova Scotia:</i> "Nova Scotia Factories Act," 1901.</p>	<p><i>Brass, iron and steel foundries:</i> "Smoke, steam, and gases generated in foundries shall be promptly and effectively removed therefrom, and whenever it is necessary, exhaust fans of sufficient capacity and power properly equipped with piping and hoods, shall be provided and operated to remove such smoke, steam and gases. The milling and cleaning of castings shall be done in rooms not otherwise used during the process of such milling or cleaning, and provision shall be made for confining and collecting the dust arising during the process."</p> <p>(Article 6 (b).)</p> <p>In every foundry employing 5 or more moulders there shall be washrooms equipped with hot and cold water . . . (and) lockers for clothes.</p> <p>(Article 6 (c).)</p>	Substantially the same as Alberta. (Article 10 (1).)	<p>The same as Manitoba. (Article 9 (1), and Article 13.)</p>	Substantially the same as British Columbia. (Article 16 (3).)	Substantially the same as Alberta. (Article 6 (3).)	Substantially the same as Alberta. (Article 7 (2).)		In foundries. See under Special Regulations for certain lead trades.	
<p><i>Ontario:</i> "Factory, Shop and Office Building Act," 1918.</p>			<p>Employment of young girls and youths may be prohibited in work deemed "dangerous or unwholesome."</p> <p>(Article 28.)</p>	<p>Children and women may be prohibited from taking meals in any room where any manufacturing process is going on "if the inspector directs."</p> <p>(Article 39 (a).)</p> <p>With regard to rooms where paint, dye, white lead, etc., is exposed, Regulation is the same as Alberta.</p>	Substantially the same as Alberta. (Article 43 (d).)	Substantially the same as Alberta. (Article 43 (g) (3).)		<p>Washroom, clean towels, soap, and in foundries, showers.</p> <p>(Article 43 (f).)</p>	<p>"Sufficient supply of wholesome drinking water and proper drinking cups."</p> <p>(Article 43 (f).)</p>
<p><i>Quebec:</i> "Industrial Establishments Act," 1909.*</p>	<p>Canning works (soldering of boxes). Can manufacturing (soldering of boxes). Smelting and rolling of iron, brass, lead, zinc. Paint (boxing and canning of). White lead.</p> <p>The above are among the occupations classified as "dangerous" in which boys must be over 16, women over 18.</p> <p>Schedule of dangerous establishments.</p>	<p>"Industrial establishments . . . must be so installed and maintained that the health and lives of the workmen shall be protected as efficiently and to as great an extent as possible against the risks of the trade."</p> <p>(Regulation No. 1.)</p>	<p>"In establishments classified . . . as dangerous, unwholesome or unwholesome, the ages for the employees shall not be under 16 years for boys and 18 years for girls or women."</p> <p>(Article 3833.)</p>	<p>"Workmen must not take their meals in the workshop, or in any place where work is carried on when forbidden by the inspector."</p> <p>(Regulation No. 94.)</p>	<p>"Industrial establishments . . . shall be provided with effective means for expelling . . . the gases and vapours which escape."</p> <p>(Article 3831.)</p> <p><i>Dust, Gases, Vapours, Waste.</i> (By-Laws of the Board of Health.)</p> <p>13. "All dusty gases and offensive, unhealthy and toxic vapours must be conducted directly out of the workshop as soon as they are produced . . ."</p> <p>14. "In order to provide against reeks, gases, light dusts, funnels must be constructed connected with draught-flues or any other apparatus for an efficacious elimination."</p> <p>15. "Millstones, threshers, crushers and other mechanical apparatus must be enclosed in drums put in direct communication with a strong aspirator in order that dust be removed."</p> <p>17. "The pulverization of irritating or toxic matters or other operations, such as sifting and packing, must be done mechanically in closed apparatus."</p> <p>18. "When there is but a part of industrial operations that causes dusts, gases, or vapours, the sanitary physician may require that such operations which he is to designate, are to be carried on in rooms entirely separate from the rest of the establishment."</p>	<p>"Industrial establishments . . . shall be provided with effective means for expelling the dust produced during the work."</p> <p>(Article 3831.)</p>	<p>" . . . in establishments where deleterious gases or dust are generated the employees shall be provided with respirator masks approved by the inspector."</p> <p>(Regulation 104.)</p>	<p>"Employers will give their employees facilities for securing individual cleanliness."</p> <p>(Regulation No. 93 (a))</p> <p>Foundries employing more than 50 persons shall have a shower bath room with hot and cold water.</p> <p>(Foundries, Article 9.)</p>	<p>"Employers will give their employees . . . water of good quality."</p> <p>(Regulation No. 93 (a).)</p>
<p><i>Saskatchewan:</i> "The Factories Act," 1919-20.</p>		<p>"No person shall keep a factory so that . . . the health of any person employed therein is likely to be permanently injured."</p> <p>(Regulation 20.)</p>	<p>Employment of youths and young girls in work deemed "dangerous or unwholesome" may be prohibited.</p> <p>(Regulation No. 7.)</p> <p>"It shall be unlawful to employ in a factory any youth, young girl or woman so that (his or her) health is likely to be permanently injured."</p> <p>(Regulation No. 10.)</p>	<p>Youths, young girls and women may be prohibited from taking meals in any room where any manufacturing process is going on "if the inspector so directs."</p> <p>(Regulation 11 (3).)</p>	Substantially the same as Alberta. (Regulation 17 (4).)	Substantially the same as Alberta. (Regulation 17 (7).)			<p>Proper drinking cups and a supply of wholesome drinking water.</p> <p>(Regulation 17 (8).)</p>

*It is understood that arrangements for doctors' visits and medicated gargles are provided by the manufacturers, who keep posted up in the factory a series of shop regulations partly inspired by the Department of Public Works and Labour.

Noxious processes—meals (Article 34)

- (1) No person is allowed to take meals in room where noxious process is being, or "during any previous part of the day has been," carried on.

Sanitation (Article 44)

Provision is made for removal of gases, fumes and dust; ventilation; drinking water.

(3) Australia

From the texts here reproduced it will be seen that the legislation enacted is far less detailed than that of Great Britain, Europe, and U.S.A., leaving more to the discretion of employers. The New South Wales Mines Inspection Act of 1901 requires employers to report both certified and alleged cases of lead poisoning, but neither in New South Wales nor in Victoria does there appear to be any requirements for medical supervision, periodic examination of lead workers or the keeping of a health register. Victoria has, however, the following regulation:

"There shall be kept available for the use of employees either:

- (a) A medicinal compound prescribed by a duly qualified medical practitioner . . . or,
- (b) A medicinal compound of the following ingredients: Sulphate of magnesium (Epsom salts), 2 ounces; water, 1 gallon; lemon syrup, sufficient to flavour."

(1) Regulations regarding the manufacture of white lead, red lead and litharge (Victoria)¹

(8. 9. 1920)

Whereas by The Factories and Shops Acts it is amongst other things enacted that the Governor in Council may, if the minister has certified that any manufacture, plant, process or labour used in factories is dangerous, make such regulations as may be deemed necessary and reasonably practicable to decrease or prevent danger from such manufacture, plant, process or labour. And whereas the Honourable Matthew Baird, His Majesty's Minister of Labour for the State of Victoria, has certified that the manufacture of white lead, red lead, or litharge is dangerous generally; Now therefore His Excellency the Lieutenant-Governor of the State of Victoria, by and with the advice of the Executive Council thereof, under the powers hereinbefore recited as well as under all other powers by the said Acts him enabling in that behalf, doth make the following Regulations regarding employment in the manufacture of white lead, red lead, or litharge (that is to say):

The manufacture of white lead, red lead, or litharge.

Duties of employer.

1. No male under eighteen years and no female of any age shall be employed at any work exposing him or her to the dust of white lead, red lead, or litharge.
2. For every employee at any work exposing him to the dust of white lead, red lead, or litharge, overalls of an approved pattern and material shall be provided, maintained, and at least once a week thoroughly cleaned.
3. For every employee engaged in packing or handling dry white lead, dry red lead, or litharge or drawing stoves, a respirator of approved pattern and material shall be provided. Every respirator shall be cleaned daily, and, when not in use, shall be kept in a suitable place set apart for the purpose.
4. The floors of the workroom shall be cleaned daily after being thoroughly damped.
5. The dressing room, bath, lavatory, and sanitary conveniences shall be thoroughly cleaned daily.

¹ Gilbert Stone, *Laws and Regulations relating to Lead Poisoning*, 1922, pp. 121-123.

6. Before each meal, in addition to regular meal times, and before the end of the day's work, at least ten minutes shall be allowed to each worker for washing.
7. An adequate supply of hot and cold water, soap, turpentine or oil, nail brushes, and clean towels shall be provided and maintained in the bathroom.
8. There shall be kept available for the use of employees either:
 - (a) A medicinal compound prescribed by a duly qualified medical practitioner as being suitable for counteracting the pathological effects of lead absorption or for aiding elimination of lead from the human system, or
 - (b) A medicinal compound of the following ingredients: sulphate of magnesium (Epsom salts), 2 ounces; water, 1 gallon; lemon syrup, sufficient to flavour.

Duties of employees.

9. No person shall smoke nor chew tobacco nor take snuff while employed in a lead process.
10. No person shall partake of nor prepare food or drink while employed in a lead process.
11. No person shall perform any work involving exposure to lead dust unless he has on an overall suit and head-covering, and no person shall work at drawing stoves, or packing, or handling dry white lead, red lead or litharge, unless he is also wearing a respirator.
12. No person, on leaving a workroom, shall enter the luncheon room nor partake of food until he has taken off his overalls, head-covering and respirator and placed them in the place provided for the purpose, nor until he has also thoroughly washed face and hands in the lavatory.

To follow Chapter 1, Clause 6, Class "F" of the Regulations under the Factories and Shops Acts, made on the third day of February, 1920.

Class G.

Buildings for the manufacture of white lead, red lead, or litharge:

All floors shall be imperviously paved and laid so as to drain into impervious drains.

Efficient control of dust and fumes shall be provided by exhaust draught, etc.

A luncheon room shall be provided for the use of employees, so constructed and placed as to be free from dust or fumes generated in the manufacturing process, and having no direct communication with a workroom.

Two dressing-rooms shall be provided. In the first shall be removed and stored all private clothing put off by the workmen during working hours. In the second shall be put on, removed and stored all overalls and other clothing worn only while at work.

Such dressing-rooms shall be so constructed and placed as to be free from any dust or fumes generated in the manufacturing process.

A bathroom with bath and lavatory accommodation shall be provided. The lavatory accommodation may consist of lavatory basins or washing troughs as follows:

One lavatory basin to every five persons or fraction of five persons employed, or washing troughs of sufficient length to allow two feet at least to every five persons or fraction of five persons employed. If practicable, the bathroom shall be situated between the dressing-rooms.

A closed cupboard shall be provided wherein to keep respirators when not in use, also apparatus for washing and sterilizing them.

And the Honourable Matthew Baird, His Majesty's Minister of Labour for the State of Victoria, shall give the necessary directions herein accordingly.

(2) Mines Inspection Act, 1901 (New South Wales)¹
Section 48

Regulations for the prevention of lead poisoning.

Record of cases of lead poisoning.

1. The manager of every mine shall record the name, age, branch of occupation, and length of time employed of every workman laid off on a medical certificate by lead poisoning; and also every workman laid off on account of alleged lead poisoning where no medical certificate is produced; and shall transmit a copy of each month's record (distinguishing certified from uncertified cases) to the Chief Inspector of Mines not later than the seventh day of the next following month.

Supply of drinking water.

2. The owner of every mine shall provide ample supply of sweet and wholesome drinking water, which shall at all times be freely and easily available to all persons at the mine; it shall be stored in such a manner as to prevent contamination by dust.

Canvas bags or wooden barrels for containing drinking water must be supplied by the owner of every mine, made according to a pattern approved by the Chief Inspector of Mines; such

¹ Gilbert Stone, *Laws and Regulations relating to Lead Poisoning*, 1922, pp. 124-126.

bags shall be so constructed as to be closed at the top by a solid (not canvas) cover, the water shall be drawn from them through a metal or wooden tap (not a canvas pipe), suitably fixed to the bottom of the bag.

The barrels shall be supplied with a metal tap for pouring off the water. Such bags or barrels shall be stored in a cool place, and shall be kept replenished with water in sufficient quantity for the use of all persons employed in or about the mine.

The vessels for drinking purposes shall hang in an enclosed place, and be thoroughly protected from dust.

If preferred, the drinking water may be supplied by pipes to every plat; the supply pipe shall descend to the lowest plat, and shall there enter a closed metal reservoir of at least 100 gallons capacity for cooling purposes; the delivery pipe shall return from the reservoir to the surface, and shall be fitted with a tap at every plat for the supply of water. The source of supply for this system shall be either public water-mains or well protected reservoirs of condensed water at the surface.

No person employed in a mine shall carry any vessel containing tea, water, or other fluid for drinking purposes, unless covered by a tight-fitting lid, which shall not be removed in the mine except when a drink is required.

Sprinkling water and water for washing.

3. On feed floors, tapping floors, and at every other place where dust is raised, stand-pipes and hose or other suitable contrivances shall be provided by the owners, so that dust may be conveniently laid by sprinkling water; water for sprinkling shall also be furnished in the main drive on all the different levels, so that it can be led to every working and easily distributed to lay dust. Proper provision shall be made in all the levels to enable men to wash their hands. Every person employed in a mine shall wash his hands before meals.

Bath-water, bathing and changing-room.

4. At every mine or works where lead, lead ores or lead compounds are mined, dressed, smelted or manufactured, bath-houses and changing-rooms shall be provided by the owners to the satisfaction of the Chief Inspector of Mines.

The baths shall include both shower and plunge tanks.

The changing rooms shall be separate from the bath-house, although attached to, and in communication with, it, and shall have boarded floors.

Both bath-house and changing-rooms shall be available to the workmen, free of cost, at all reasonable hours, and so that they can be used by every shift.

They shall be sufficiently lighted after dark, and warmed in cold weather.

Both plunge and shower baths shall be supplied with water, warmed to at least 75 degrees Fahrenheit in cold weather.

A caretaker shall always be in charge of bath-houses and changing rooms, and it shall be part of his duty to keep a daybook, and to record therein the names of all persons who use the baths.

Change of clothes.

5. Every underground workman shall change his ordinary clothes for working clothes in the changing-rooms before descending to his work, and shall change clothes again on finishing work, and before leaving the mine. Surface workmen engaged in smelting, or otherwise handling lead ores, shall also make the same change of clothes.

Flue dust.

6. Adequate provision shall be made by the owner of every mine to prevent as far as practicable, the emission of flue-dust from smelter stacks. If the Inspector considers any alteration or any additional appliances are necessary for that purpose, he may, by written notice, require the owner to make or supply the same, and in such notice a reasonable time shall be named within which such required alterations, or additions are to be made. If any owner objects to any requirement of the Inspector in this direction, he may, within the time named in the notice, show cause in writing to the Chief Inspector of Mines, who may confirm, vary, or veto the notice of the Inspector.

Flue dust—how to be dealt with.

7. The ports by which flue-dust is removed from champion flues shall not open into tapping floors, but the outlets shall be on the other side of the flues, into a space otherwise unoccupied.

The floors to which the dust falls when first hoed out shall be smooth and impermeable, and shall be provided with a kerb raised above the surrounding surface, so that the deposited dust or mud may not be stepped on and carried about; the floors shall be perfectly clean, except when in actual use.

Workmen employed to cleanse flues and to gather and transport flue dust, shall be under the same obligation to change clothes before going on shift as underground hands.

And no person shall be so employed unless wearing a suitable respirator, to cover his nose and mouth, or to engage in work, or stand about where others are so employed, unless he put on a respirator.

The flue-dust shall be carefully wetted as soon as it is drawn from the flue. No accumulation of wet flue dust shall be permitted in any mine, unless within a securely-closed receptacle; nor shall any accumulation of dry flue dust be permitted outside the flues, but shall forthwith be charged back regularly.

Ventilation of tapping floors.

8. Tapping floors shall be ventilated at the angle between the top of the champion flue and the feed floor, to reduce draft on the tapping floor, and to afford fumes a way of escape; flues of large diameter may be carried up through the feed floor without interfering with operations there, and they may expand below into oblong funnel-shaped openings.

Repairing furnaces in blast.

9. No workman shall engage in repairing a furnace in blast (as in replacing a faulty water-jacket panel) unless he wears a respirator, as mentioned in Regulation No. 7.

Fumes from molten metal and slag.

10. Furnaces shall be surrounded with a hood, which shall expand below, so as to catch fumes from molten metal and slag. Such hood shall terminate on one side in a chimney leading to the air on the open side of the tapping-floor.

Copy of regulations to be supplied to workmen.

11. A printed copy of these Regulations shall be presented by the Manager to each workman in engaging him.

Enforcement of regulation penalties.

12. If any person shall, after written notice served on him by an Inspector, refuse or neglect to comply with any such regulation, he shall be liable to a penalty not exceeding 20 pounds, and to a further penalty not exceeding 5 pounds for every day during which the offence is continued after receipt of the notice aforesaid; and any Inspector authorized to do so by the Chief Inspector of Mines or other person authorized by the Minister, may recover such penalties in the manner prescribed by the Act.

(3) **Factories and Workshops Act, 1912. (New South Wales.)**¹

SCHEDULE TWO.

Factories in which employment of persons is restricted.

1. In a part of a factory in which there is carried on
 - (a) the process of silvering of mirrors by the mercurial process; or
 - (b) the process of making white lead;
 a person under eighteen years shall not be employed.

* * * * *

5. No person under sixteen years of age shall be employed at or in connection with any manufacturing process or machine where continuous casting from molten lead or any combination thereof is carried on in a printing establishment.

(4) **General rules for smelting works only, whether carried on in connection with mining operations or not. (Tasmania.)**²

(Mines and Works Regulations Act, 1915. Tasmania.)

1. The owner, agent, or manager of every smelting works shall provide an ample supply of pure drinking water for the use of all persons employed in or about such works, and such supply shall be freely and easily available. All necessary provision shall be made for preventing such water becoming polluted or being rendered unwholesome.

2. No person employed in or about any smelting works shall carry any vessel containing tea, water, or other fluid for drinking purposes unless the vessel is covered by a tight-fitting lid, which shall not be removed in the works, except when a drink is required.

3. On feed floors, tapping floors, and at every other place in any smelting works where dust is raised, stand pipes and hose or other suitable contrivances shall be provided by the owner, agent, or manager of such works, together with an ample supply of water for sprinkling, so that the dust may be conveniently laid. Proper provision shall be made in every smelting works to enable men to wash their hands.

¹ Gilbert Stone, *Laws and Regulations relating to Lead Poisoning*, 1922, p. 127.

² *Ibid.*, pp. 127 and 128.

4. At every smelting works where lead ores are smelted, sufficient accommodation in the way of bath-houses and changing-rooms shall be provided by the owner, agent, or manager of such works to the satisfaction of an Inspector; and such accommodation shall be available to the workmen free of cost at all reasonable hours, and for use by every shift. An adequate supply of clean water shall be provided, warmed to at least 70 degrees Fahrenheit in cold weather, and be available for such bath-houses. A caretaker shall be in charge of bath-houses and changing rooms; and it shall be part of his duty to keep a day-book and to record therein the names of all persons who use the baths. No person shall destroy, damage, deface, or disfigure any bath-house or changing-room, or any appliances therein, or used in connection therewith, nor be guilty of unseemly or indecent conduct. No person shall enter or use any bath-house or changing-room whilst in an intoxicated state.

5. Adequate provision shall be made by the owner, agent, or manager of every smelting works to prevent, as far as practicable, the emission of flue-dust from smelter stacks.

6. Adequate provision shall be made for carefully wetting flue-dust as soon as it is drawn from the flue. Flue-dust shall not be permitted to accumulate so as to be a nuisance to the health of workmen.

7. At all works where lead ores are smelted, furnaces shall be surrounded with a hood, which shall expand below so as to catch fumes from molten metal and slag. Such hoods shall terminate in a chimney, or other means of access to the air.

Compensation for occupational diseases

Certain occupational diseases have recently been made compensable.¹

(4) Union of South Africa

Factory Act, 1918²

Section 20. No boy or girl under the age of 16 years shall be employed:

- (i) as a typesetter in or about any printing works or in any room where bronzing is being carried on or where type or type metal is being cast or melted;
- (ii) in any room in which there is carried on continuous dry grinding in the metal trade or the dipping of matches in the manufacture of which white or yellow phosphorus is used;
- (iii) in any factory in the actual making or finishing of bricks or tiles (not being ornamental tiles) or in the making or finishing of salt.
- (iv) in any room in which there is carried on the process of melting or annealing glass.

No boy under the age of 18 years, and no female of any age, shall be employed in any room in which there is carried on the silvering of mirrors by the mercurial process or the making of white lead or the grinding of paints or articles containing white lead.

Section 24. The Governor-General may, from time to time, by proclamation in the *Gazette*, declare any handicraft, process, or occupation to be for the purposes of this Act a noxious handicraft, process, or occupation or, by like proclamation, may declare any occupation to be a dangerous occupation.

A copy of every such proclamation shall be laid upon the Tables of both Houses of Parliament within 14 days after its publication if Parliament is then in session or, if Parliament is not then in session, within 14 days after the commencement of its next session.

Section 25. Whenever a proclaimed noxious or dangerous handicraft, process or occupation is carried on in a factory, the occupier shall be guilty of an offence if any person employed in the factory takes a meal in a room or place in which the noxious or dangerous handicraft, process or occupation has been carried out, and the person who takes a meal in such a room or place shall likewise be guilty of an offence.

Section 29 (d). The factory shall be ventilated in such manner that a sufficient supply of fresh air is provided for the persons employed therein and that, so far as possible, all gases, fumes, dust and other impurities arising in the course of the work carried on in the factory are removed or rendered harmless, and that wholesome temperature is maintained.

(5) Rhodesia

Regulations to be observed in the working of blast furnaces³

Employees on blast furnaces are hereby notified that the directions given below are to be followed.

These instructions are drawn up for the purpose of protecting the health of the workmen, and every care should be taken to carry them out:

- (1) See that the appliances for carrying away the fumes are working in a proper manner.
- (2) All floors to be constantly sprinkled with water.
- (3) Wear respirators in the presence of fumes, especially when "cutting out."

¹ Monthly Labor Rev., U.S. Bur. Lab. Stats., XIII, No. 1, July, 1921, p. 216.

² Gilbert Stone, Laws and Regulations relating to Lead Poisoning, 1922, p. 129.

³ Ibid., p. 130.

(4) No food shall be eaten while on duty on the furnaces, and no food must be kept where fumes or dust may settle on it, and smeltermen should keep a special suit in which to work, and which should be lodged in the change house when going off shift.

(5) No smelterman shall leave the furnace, or partake of meals, without previously and carefully cleaning and washing his hands, and he must observe strict cleanliness everywhere, to prevent fumes or dust coming into contact with food or drink.

(6) Do not rub tobacco up in the hands, but use it ready cut up.

(7) On going off shift, make use of the hot bath provided.

(8) Drink oatmeal water in the quantities provided.

(9) Take the pills provided—one every four hours. These are harmless, but act as a corrective.

ROSS MACARTNEY,

General Manager.

Broken Hill.

(6) India

Indian Factories Act, 1911¹

10. After Section 9 of the said Act, the following Sections shall be inserted, namely:

19 (b) No woman and no person under the age of eighteen years shall be employed in any factory in any of the operations specified in Part I of Schedule 1, or, save in accordance with the regulations contained in Part II of Schedule 1, in any operation involving the use of lead compounds.

SCHEDULE 1.

Schedule (1) to be substituted in The Indian Factories Act, 1911.

The Schedule—Part I.

1. Work at a furnace where the reduction or treatment of zinc or lead ores is carried on.
2. The manipulation, treatment or reduction of ashes containing lead, the desilverizing of lead, or the melting of scrap lead or zinc.
3. The manufacture or solder or alloys containing more than 10 per cent. of lead.
4. The manufacture of any oxide, carbonate, sulphate, chromate, acetate, nitrate, or silicate of lead.
5. Mixing or pasting in connection with the manufacture or repair of electric accumulators.
6. The cleaning of work-rooms where any of the processes aforesaid are carried on.

Part II.

1. Where dust or fume from a lead compound is produced in the process, provision must be made for drawing the fume or dust away from the persons employed by means of an efficient exhaust draught so contrived as to operate on the dust or fume as nearly as may be at its point of origin.

2. The persons employed must undergo the prescribed medical examination at the prescribed intervals, and the prescribed record must be kept with respect to their health.

3. No food, drink or tobacco shall be brought into, or consumed in, any room in which the process is carried on, and no person shall be allowed to remain in any such room during meal times.

4. Adequate protective clothing in a clean condition shall be provided by the employer and worn by the persons employed.

5. Such suitable cloak-room, mess-room and washing accommodation as may be prescribed shall be provided for the use of the persons employed.

6. The rooms in which the persons are employed, and all tools and apparatus used by them, shall be kept in a clean condition.

¹ Gilbert Stone, *Laws and Regulations relating to Lead Poisoning*, 1922, p. 131.

CHAPTER III

U. S. A.

(1) Scope and analysis of the laws

There is no federal law governing the lead trades. The legislation in the different states, mostly dating from 1911, varies enormously but the main tendency is to have legislation dealing with occupational disease in general with special bearing on lead poisoning rather than, as in Great Britain and Europe, legislation referring to individual lead trades specifically. New Jersey, which has laws relating to the lead and copper industries, printing and pottery, is the exception to this rule. Various of the states include in their general Factory Acts sections restricting the employment of women and children in certain hazardous work, including lead processes, and prohibiting the taking of food in rooms where poisonous substances, including lead, are present. Other sections dealing with washing facilities, removal of noxious or injurious fumes, dusts, or gases, and provision of drinking water touch the subject generally, with less direct reference to lead.

(A) States which have no lead legislation whatsoever

So far as can be ascertained, the following states have no lead legislation either as such or included in general occupational disease legislation. They have no occupational disease reporting law and allow no compensation for occupational diseases. The only legislation affecting lead is that contained in provisions of the general Factory Acts regulating such questions as employment of women and children, dust and fume removal, eating in workrooms, etc.

Arkansas	Vermont	Wyoming	Indiana
Alabama	Nebraska	Oregon	Kansas
Colorado	Washington	Montana	Oklahoma
Delaware	Kentucky	Nevada	Utah
Idaho	Mississippi	Iowa	

(B) Summary of lead legislation in other states

The legislation existing in the various states may be briefly summarized under the following heads:

- (1) Typical extracts, referring to lead, from general Factory Acts.
- (2) Legislation referring to occupational diseases in general or lead poisoning in particular.
- (3) Legislation on individual lead trades.
- (4) Legislation requiring the reporting of occupational diseases, including lead poisoning.
- (5) Compensation for occupational diseases, including lead poisoning.

(1) Typical extracts, referring to lead, from general factory acts

New York (extracts from Labour Law with amendments, additions and annotations to August 1st, 1922).

(a) Employment of children. (Section 146-2.)

"No child under 16 shall be employed in or assist in . . . (c) manufacturing or packing paints, dry colours, or red or white leads."

(b) Eating in workrooms. (Section 205.)

"No employee shall take or be permitted to take any food into a room of any working place where lead, arsenic, or other poisonous substance or injurious or noxious fumes, dust or gases exist in harmful conditions or are present in harmful quantities as an incident or result of the business carried on in such working place. Notice to the foregoing effect shall be posted in such room. No employee unless his presence is necessary for the proper conduct of the business, shall remain in any such room during the time allowed for meals. The employer shall provide a suitable place in such establishments in which the employees may eat."

(c) Suction devices for removal of fumes. (Section 299-3.)

"If dust, gases, fumes, vapours, fibres, or other impurities are generated or released in the course of the business carried on in any workroom of a factory, in quantities tending to injure the health of the employees, suction devices shall be provided which shall remove such impurities from the workroom, at their point of origin where practicable, by means of proper hoods connected to conduits and exhaust fans. Such fans shall be kept running constantly while the impurities are being generated or released."

(d) Washing facilities. (Section 293-2.)

"In factories where lead, arsenic or other poisonous substances or injurious or noxious fumes, dust or gases are present as an incident or result of the business or occupation, hot water, soap and individual towels shall be furnished."

These quotations are fairly typical of the regulations bearing on lead included in various of the Factory Acts, but many are less specific.

(2) Legislation referring to occupational diseases in general or lead poisoning in particular**(a) New Jersey, Ohio, Pennsylvania.****New Jersey**

has a law dating from April, 1914, entitled "An Act to prevent lead poisoning and other occupational diseases." The trades covered are (a) "Every work or process in the manufacture of white lead, red lead, litharge, sugar of lead arsenate of lead, lead chromate, lead sulphates, lead nitrate, or fluo-silicate . . ."

(b) "Every work or process in the manufacture of pottery, tiles, or porcelain-enameled sanitary ware. . . ."

Ohio

has a law dating from October, 1913, entitled, "For the prevention of occupational diseases with special reference to lead poisoning." The trades covered are the same as (a) above.

Pennsylvania

has a law dating from July, 1913, entitled "An Act to prevent occupational diseases; and to provide for the health of employees exposed to the danger

of lead poisoning and other occupational diseases, by regulating certain manufacturing establishments; providing for medical examinations and reports and requiring sanitary precautions and appliances. . . ." The trades covered are the same as (a) above.

(b) *Missouri and Illinois.*

Missouri

has a law dating from 1913, entitled "Occupational Disease Law." The trades covered are "the carrying on of any process or manufacture, or labour in this state in which antimony, arsenic, brass, copper, lead, mercury, phosphorus, zinc, their alloys or salts or any poisonous chemicals, minerals, acids, fumes, vapours, gases, or other substances, are generated or used, employed or handled by the employees in harmful quantities, or under harmful conditions, or come in contact with in a harmful way. . . ."

Illinois

has a law dating from July, 1911 (amended July, 1921), entitled "Occupational Disease Law." The trades covered are "the carrying on of any process of manufacture or labour in which sugar of lead, white lead, lead chromate, litharge, red lead, arsenate of lead or Paris green are employed, used or handled, or the manufacture of brass or the smelting of lead or zinc. . . ."

As has been seen, the application of these laws varies slightly. The content is, however, substantially the same and includes the following points:

- (1) Devices for dust prevention.
- (2) Washing facilities.
- (3) Dressing rooms.
- (4) Eating rooms and prohibition of eating in workrooms, if lead is present.
- (5) Drinking water.
- (6) Working clothes.
- (7) Respirators.
- (8) Posting of notices *re* danger and prevention of lead poisoning.
- (9) Monthly medical examination of workers exposed to lead.
- (10) Reporting by physicians to state authority of cases of lead poisoning.

(c) *New York.*

New York has no lead law comparable with that of the states just mentioned. The extracts from the general factory law bearing on lead have already been quoted, and in addition to the requirements for reporting occupational diseases and for compensation dealt with later under the appropriate headings, there are, as part of the industrial code, special rules for the removal of lead dusts and fumes. These rules, which refer to artificial means of removing dust and fumes and include a requirement for the provision of respirators, refer to the following trades: "Every work or process in the manufacture or use of white lead, red lead, litharge, sugar of lead, arsenate of lead, lead chromate, lead sulphate, lead nitrate or fluo-silicate, or in the manufacture of pottery, tiles, or porcelain-enameled sanitary ware, including the corroding or oxidizing of lead and the crushing, mixing, sifting, grinding and packing of all lead salts or other compounds. . . ."

(3) Regulations in individual lead trades

New Jersey seems to be the only state influenced by the European and British tendency to legislate for the lead trades individually, and it is not clear whether the following instances have *legal* force.

In 1914 the Commission of Labour issued a circular letter to the lead and copper industries containing the sanitary regulations "approved by the department of Labour." These regulations include practically all the precautions in force in Europe and Great Britain.

In addition, the Department of Labour has issued regulations for the hygiene of printing and typecasting establishments, and standard regulations for removing dust generated in the manufacture of pottery.

Louisiana has a brief Act requiring the use of artificial ventilation in connection with linotype machines.

Virginia has a law dating from 24.3.22, requiring the labeling of receptacles containing "paint," the term covering "oxide of zinc, red lead and white lead (basic carbonate or basic sulphate), dry or in any kind of oil, or any compound intended for the same use; paste or semi-paste paint, and liquid or mixed paint for use on buildings, fences and structures."

(4) Legislation requiring the reporting of occupational diseases including lead poisoning

(Ohio, New York, Rhode Island, New Mexico, Maryland, Massachusetts, California, New Hampshire, Connecticut, Maine, New Jersey, Missouri, Pennsylvania, Illinois, Michigan, Minnesota, Wisconsin.)

The legislation under this head is of four kinds:

(a) Every physician is required to report cases of lead poisoning.

This is the case in Ohio¹, New York², Rhode Island³, New Mexico⁴, Maryland⁵, Massachusetts⁶, New Hampshire⁷, Connecticut⁸, Maine⁹, Michigan¹⁰, and Wisconsin¹¹.

(b) The physicians examining workers in certain lead trades, in accordance with The Occupational Disease Acts, are required to report cases of poisoning.

This is the case in New Jersey¹², Missouri¹³, Pennsylvania¹⁴, and Illinois¹⁵.

(c) The physicians attending injuries (term includes diseases arising out of employment) in connection with The Workmen's Compensation Act are required to report them.

This is the case in California.¹⁶

(d) Employers required to report occupational diseases in accordance with The Workmen's Compensation Act. This is the case in Minnesota.¹⁷

¹ Ohio, An Act to require the reporting of Occupational Diseases, as amended February 4, 1920. Section 1243.

² New York, Labor Law with amendments, additions and annotations to August 1, 1922. Section 206.

³ Rhode Island, Labor Laws, Chap. 1226, 1915.

⁴ New Mexico, Recommendation of the Board of Health (Letter from New Mexico Bureau of Public Health).

⁵ Maryland, Acts 1912, Chap. 165.

⁶ Massachusetts, General Laws, Chap. 149. Section 11 (p. 9, Manual of the Labor Laws, Nov., 1921).

⁷ New Hampshire, An Act to require the reporting of certain occupational diseases, Laws of 1913, Chap. 118.

⁸ Connecticut, Labor Laws, Revision of 1920, p. 62, Section 2416.

⁹ Maine, Labor Laws of Maine, 1921, Revision, p. 12 (Chap. 19, Section 19, 1913. C. 82, No. 1).

¹⁰ Michigan, Acts, 1911, No. 109.

¹¹ Wisconsin, Laws, 1911, c. 252.

¹² New Jersey, An Act to prevent Lead Poisoning and other occupational disease and providing penalties for the violation of its provisions, 1914, Chap. 162. Section 7.

¹³ Missouri, Occupational Disease Law, Laws 1913, p. 402, section 6821. (Laws, rules and regulations covering Industrial Inspection, revised, 1921, p. 14).

¹⁴ Pennsylvania, An Act to prevent occupational diseases, and to provide for the health of employees exposed to the danger of lead poisoning and other occupational diseases. No. 851, 1913, section 7.

¹⁵ Illinois, Occupational Disease Law, 1911, Section 4.

¹⁶ California, Workmen's Compensation, Insurance and Safety Act, 1913, amended 1915, 1917 and 1919. Section 53, amended Stats., 1919, p. 924 (Labor Laws, 1921, p. 212.)

¹⁷ Minnesota, Workmen's Compensation Act, Chap. 82, G. L., 1921.

(5) Compensation for occupational diseases including lead poisoning

(Ohio, New York, Minnesota, Massachusetts, Wisconsin, California, Connecticut, Hawaii, Illinois, Porto Rico, North Dakota.)

In the majority of the states occupational disease is not compensable, and it is only within very recent years that a few of the states have passed legislation including such diseases in the operation of The Workmen's Compensation Acts. The actual position is somewhat obscure as in some cases compensation is actually paid for diseases arising out of employment, although nothing in the Acts expressly states that this is the case. Thus, in most states the term "injury" is interpreted solely as referring to accidents, while in others a wider meaning including disease is in practice allowed. So far as can be ascertained, the position at the end of 1922 was as follows:

*Ohio*¹, *New York*², and *Minnesota*³ have amended their Workmen's Compensation Laws to provide for compensation for certain scheduled occupational diseases, including lead poisoning.

*Wisconsin*⁴ has amended its Workmen's Compensation Act "to include in addition to accidental injuries, all other injuries, including occupational diseases, growing out of or incidental to the employment."

*California*⁵, in The Workmen's Compensation, Insurance and Safety Act, 1913, as amended 1917, defines injury as "any injury or disease arising out of the employment."

*Illinois*⁶ in 1921 passed an Act to amend its Occupational Disease Law, and provided that "the disablement of an employee engaged in occupations covered by section 2 of this Act (these include lead trades) resulting from an occupational disease arising as a result of the work, labour, manufacture, or process referred to . . . shall be treated as the happening of an accidental injury within the terms and meaning of The Workmen's Compensation Act."

In *Massachusetts*⁷ and *Connecticut*⁸ the Workmen's Compensation laws allow compensation for "personal injury . . . arising out of or in the course of . . . employment." This applies to occupational diseases including lead poisoning.

In *North Dakota*⁹ the Workmen's Compensation Act defines injury as "only an injury arising in the course of employment." The question as to whether or not an occupational disease as such should be classed as an injury has never been passed upon by the courts, but the tendency of the Bureau is to treat such diseases as injuries.¹⁰

Hawaii and *Porto Rico* are also said to include in their Workmen's Compensation laws provision for compensating occupational diseases.

(2) Text of the lead laws

(1) Typical extracts, referring to lead, from general Factory Acts

A fairly typical example, that of New York, has already been quoted, see page 189.

¹ Ohio, House Bill No. 47, 1921.

² New York, Workmen's Compensation Laws with Amendments, Additions and Annotations to 1. 8. 22., p. 35.

³ Minnesota, Workmen's Compensation Law, June, 1921, Section 67-71.

⁴ Wisconsin, Workmen's Compensation Act with 1921 amendments, Section 2394-32.

⁵ California, Workmen's Compensation, Insurance and Safety Act, 1913, amended 1917 and 1919, Section 3(4).

⁶ Illinois, An Act to amend Section 15 of The Occupational Disease Law, 1921.

⁷ Massachusetts, Workmen's Compensation (General Laws, Chap. 152).

⁸ Connecticut, Workmen's Compensation Act, as amended 1919, Section 5339.

⁹ North Dakota, Workmen's Compensation Act, 1919, as amended 1921, House Bill No. 56, Chapter 162, Section 2.

¹⁰ Letter 6. 1. 23, from Secretary Workmen's Compensation Bureau, Bismarck.

(2) Legislation referring to occupational diseases in general or lead poisoning in particular

(a) *New Jersey, Ohio and Pennsylvania.***New Jersey: An Act to prevent lead poisoning and other occupational diseases and providing penalties for the violation of its provisions.
(April, 1914.)**

Be it enacted by the Senate and General Assembly of the State of New Jersey:

1. General duties of employers.

Every employer shall, without cost to the employees, provide reasonably effective devices means and methods to prevent the contraction by his employees of any illness or disease incident to the work or process in which such employees are engaged.

2. Especially dangerous works or processes.

(a) Every work or process in the manufacture of white lead, red lead, litharge, sugar of lead, arsenate of lead, lead chromate, lead sulphates, lead nitrate, or fluo-silicate is hereby declared to be especially dangerous to the health of the employees who, while engaged in such work or process are exposed to lead dusts, lead fumes or lead solutions.

(b) Every work or process in the manufacture of pottery, tiles or porcelain enameled sanitary ware is hereby declared to be especially dangerous to the health of the employees who, while engaged in such work or process, are exposed to lead dusts or lead solutions.

3. Duties of employers to provide safety appliances for the protection of employees in especially dangerous work or processes.

Every employer shall, without cost to the employees, provide the following devices, means and methods for the protection of his employees who, while engaged in any work or process included in section two, are exposed to lead dusts, lead fumes or lead solutions.

(a) Working rooms, hoods and air exhausts for the protection of employees engaged in any work or process which produces lead dusts or lead fumes.

The employer shall provide and maintain work rooms adequately lighted and ventilated, and so arranged that there is a continuous and sufficient change of air, and all such rooms shall be fully separated by partition walls from all departments in which the work or process is of non-dusty character; and all such rooms shall be provided with a floor permitting an easy removal of dust by wet methods or vacuum cleaning, and all such floors shall be cleaned either by wet method or vacuum cleaner daily.

Every work or process referred to in section two, including the corroding or oxidizing of lead, and the crushing, mixing, sifting, grinding and packing of all lead salts or other compounds referred to in section two, shall be so conducted and such adequate devices provided and maintained by the employer as to protect the employee, as far as possible, from contact with lead dust or lead fumes. Every kettle, vessel, receptacle or furnace in which lead in any form referred to in section two is being melted or treated, and any place where the contents of such kettles, receptacles or furnaces are discharged, shall be provided with a hood connected with an efficient air-exhaust; all vessels or containers in which dry lead in any chemical form or combination referred to in section two is being conveyed from one place to another within the factory shall be equipped, at the places where the same are filled or discharged, with hoods having connection with an efficient air-exhaust; and all hoppers, chutes, conveyers, elevators, separators, vents from separators, dumps, pulverizers, chasers, dry pans or other apparatus for drying pulp lead, drying pans, dump, and all barrel packers and cars or other receptacles into which corrosions are at the time being emptied shall be connected with an efficient dust collecting system; such system to be regulated by the discharge of air from a fan, pump or other apparatus, either through a cloth dust-collector having an area of not less than one-half square foot of cloth to every cubic foot of air passing through it per minute, the dust collector to be placed in a separate room which no employee shall be required or allowed to enter, except for essential repairs, while the works are in operation; or such other apparatus as will efficiently remove the lead dusts from the air before it is discharged into the outer air.

(b) **Washing facilities.**—The employer shall provide a wash room or rooms for such employees, which shall be separate from the work rooms, be kept clean and be equipped with:

- (1) Lavatory basins fitted with waste pipe and two spigots, conveying hot and cold water; or
- (2) Basins placed in troughs fitted with waste pipes, and for each basin two spigots conveying hot and cold water; or
- (3) Troughs of enamel or similar smooth, impervious material fitted with waste pipes, and for every two feet of trough length two spigots conveying hot and cold water.

Where basins are provided there shall be at least one basin for every five such employees and where troughs are provided at least two feet of trough length for every five such employees. The employer shall also furnish nail brushes and soap, and shall provide at least three clean towels per week for each such employee. A time allowance of not less than ten minutes, at the employer's expense, shall be made to each of such employees for the use of said wash room before the lunch hour, and at the close of the day's work.

The employer engaged in the manufacture of white lead, red lead, litharge, sugar of lead, arsenate of lead, lead chromate, lead sulphate, lead nitrate, or fluo-silicate, shall also provide

at least one shower bath for every five such employees. The baths shall be approached by wooden runways, be provided with movable wooden floor gratings, be supplied with controlled hot and cold water, and be kept clean. The employer shall furnish soap and shall provide at least two clean bath towels per week for each employee. An additional time allowance of not less than ten minutes, at the employer's expense, shall be made to each such employee for the use of said baths at least twice a week at the close of the day's work. The employer shall keep a record of each time that such baths are used by each employee, which record shall be open to inspection at all reasonable times by the Department of Labour of this State and also by the State Board of Health.

(c) Dressing rooms. The employer shall provide a dressing room or rooms which shall be separate from the work rooms, to be furnished with a double sanitary locker, or two single sanitary lockers for each such employee, and be kept clean.

(d) Eating rooms. The employer shall provide an eating room, or eating rooms for such employees, and such rooms shall be separate from the work rooms, be furnished with a sufficient number of tables and seats, and be kept clean. No such employee shall take or be allowed to take any food or drink of any kind into any work room, nor shall any such employee remain or be allowed to remain in any work room during the time allowed for his meals.

(e) Drinking fountains. The employer shall provide and maintain a sufficient number of sanitary drinking fountains readily accessible for the use of such employees.

(f) Clothing. The employer shall provide at least two pairs of overalls and two jumpers for each such employee, and repair or renew such clothing when necessary, and wash the same weekly. Such clothing shall be kept exclusively for the use of that employee.

(g) Respirators. The employer shall provide and renew when necessary at least two reasonably effective respirators for each employee who, while engaged in any work or process which produces lead dusts, is exposed to such dusts; provided, if at any time it is shown to the satisfaction of the Commissioner of Labour of the State of New Jersey, in the case of any manufacturer or process or any operation forming part thereof in the potteries that injury to health is adequately prevented by other appliances or any other condition than those prescribed by law, he may modify the whole or any part of the law so far as it applies to such pottery manufacture or process.

4. *Duties of employees in especially dangerous works or processes to use the safety appliances provided by the employers.*

Every employee who, while engaged in any work or process included in section two, is exposed to lead dust, lead fumes or lead solutions, shall:

(a) Use the washing facilities provided by the employer in accord with section three (b), and wash himself at least as often as a time allowance is therein granted for such use;

(b) Use the eating room provided by the employer in accord with section three (d) unless the employee goes off the premises for his meals;

(c) Put on and wear at all times, while engaged in such work or process, a suit of clothing provided by the employer in accord with section three (f) and remove the same before leaving at the close of the day's work; and keep his street clothes and working clothes, when not in use, in separate lockers or separate parts of the locker provided by the employer in accordance with section three (c);

(d) Keep clean the respirators provided by the employer in accordance with section three (g) and use one at all times while engaged in any work or process which produces lead dusts and is exposed to such dusts.

5. *Notices.*

The employer engaged in any of the processes mentioned in section two shall post in a conspicuous place in every work room where any work or process included in section two is carried on, in every room where washing facilities are provided, in every dressing room and eating room, a notice of the known dangers arising from such work or processes and simple instructions for avoiding, as far as possible, such dangers. The Commissioner of Labour shall prepare a notice containing the provisions of this Act, and shall furnish, free of cost, a reasonable number of copies thereof to every employer included in section two, and the employer shall post copies thereof in the manner hereinabove stated. The notices required in this section shall be printed in plain type on cardboard, and shall be in English and in such other languages as the circumstances may reasonably require. The contents of such notices shall be explained to every employee who may be exposed to lead dusts, lead fumes or lead solutions, by the employer when the said employee enters employment in such work or process, interpreters being provided by the employer, when necessary, to carry out the above requirements.

6. *Medical examinations.*

The employer shall cause every employee who, while engaged in any work or process included in section two, is exposed to lead dusts, lead fumes or lead solutions, to be examined once a month for the purpose of ascertaining if symptoms of lead poisoning appear in any employee. The employee shall submit himself to the monthly examinations, and to examination at such other times and places as he may reasonably be requested by the employer, and he shall fully and truly answer all questions bearing on lead poisoning asked him by the examining physician. The examination shall be made by a licensed physician, designated and paid by the employer, and

shall be made during the working hours, a time allowance therefore, at the employer's expense, being made to each employee so examined.

7. Record and reports of medical examination.

Every physician making any examination under section six and finding what he believes to be symptoms of lead poisoning shall enter, in a book to be kept for that purpose in the office of the employer, a record of such examination, containing the names and addresses of the employees so examined, the particular work or process in which he is engaged, the date, place and finding of such examination, and the directions given in each case by the physician. The record shall be open to inspection at all reasonable times by the Department of Labour and by the State Board of Health.

Within forty-eight hours after such examination and finding, the examining physician shall send a report thereof in duplicate, one copy to the Department of Labour and one to the State Board of Health. The report shall be on or in conformity with blanks furnished by the State Board of Health, free of cost, to every employer included in section two, and shall state:

- (a) Name, occupation and address of employee.
- (b) Name, business and address of employer.
- (c) Nature and probable extent of disease.
- (d) Such other information as may be reasonably required by the State Board of Health.

The examining physician shall also, within the said forty-eight hours, report such examination and findings to the employer, and after five days from such report the employer shall not continue the said employee in any work or process where he will be exposed to lead dusts, lead fumes, or lead solutions, nor return the said employee to such work or process without a written permit from a licensed physician.

8. Enforcement.

The Commissioner of Labour shall enforce this Act and prosecute all violations of the same. The said commissioner, the assistant commissioner, and the inspectors of the said department, shall be allowed at all reasonable times to inspect any place of employment included in this Act.

9. Penalties.

Every employer who, either personally or through any agent, violates or fails to comply with any provisions of section one or section three of this Act shall be liable to penalties of fifty dollars for the first offence, one hundred dollars for the second offence and three hundred dollars for the third and each subsequent offence. Every employee who violates or fails to comply with any provisions of section four of this Act, shall be liable to a penalty of ten dollars for the first offence and twenty-five dollars for the second and each subsequent offence. Every employer who, either personally or through an agent, violates or fails to comply with any provisions of sections five, six or seven of this Act, relating to him, shall be liable to a penalty of fifty dollars for each offence, and every employee who violates or fails to comply with any provision of section six of this Act, relating to him, shall be liable to a penalty of ten dollars for each offence.

10. Any and all penalties prescribed by any of the provisions of this Act shall be recovered in an action of debt by and in the name of the Commissioner of Labour of the State of New Jersey. The pleadings shall conform in all respect to the practice prevailing in the court in which any such actions shall be instituted, but no pleading or process shall be set aside or invalidated by reason of any formal or technical defects therein, if the same contain a statement of the nature of the alleged violation and of the section of this Act alleged to have been violated, and, upon the attention of the court being called to any such formal or technical defect, the same shall be immediately corrected, and the said pleading or process amended as a matter of course, and as to all other defects in pleading or process, the same may be amended in the discretion of the court as in any other action or proceeding in said court.

11. When judgment shall be rendered against any defendant other than a body corporate, execution shall be issued against his goods and chattels and body without any order of the court for that purpose first had and obtained. If the officer executing any such writ shall be unable to find sufficient goods or chattels of said defendant in his bailiwick to make the amount of such judgment, he shall take the body of the said defendant and deliver him to the keeper of the common jail of said county, there to be detained until discharged by the court in which such judgment was obtained or by one of the justices of the Supreme Court, when such court or justice shall be satisfied that further confinement will not result in the payment of the judgment and costs. In case judgment shall be entered against a body corporate, execution shall be issued against the goods and chattels of such body corporate as in other actions of debt. Any penalty recovered in any action brought under the provisions of this Act shall be paid to the plaintiff therein, who shall pay the same to the Treasurer of the State of New Jersey.

12. Definition.

In this Act, unless the context otherwise requires, "employers" includes partnerships and corporations.

13. In case for any reason any section or any provision of this Act shall be questioned in any court, and shall be held to be unconstitutional or invalid, the same shall not be held to affect any other section or provision of this Act.

14. *Time of taking effect.*

This Act shall take effect on the first day of October, one thousand nine hundred and fourteen, except as to subdivisions (a), (b), (c) and (d) of section three, which subdivisions shall take effect as follows:

Subdivisions (b), (c) and (d) of section three, on the first day of October, one thousand nine hundred and fifteen.

Subdivision (a) of section three, on the first day of October, one thousand nine hundred and sixteen.

Approved April 14, 1914.

Ohio¹ and Pennsylvania.²

The Acts of these states are substantially the same as that of New Jersey above, save that the application does not include "the manufacture of pottery, tiles, or porcelain enameled sanitary ware," and the administration and penalties, etc., are different.

(b) Illinois and Missouri.

Illinois: Occupational Disease Law.³
(July 1, 1911)

An Act to promote the public health by protecting certain employees in this State from the dangers of occupational diseases, and providing for the enforcement thereof.

Section 1. *Be it enacted by the People of the State of Illinois, represented in the General Assembly:* That every employer of labour in this State, engaged in carrying on any work or process which may produce any illness or disease peculiar to the work or process carried on, or which subjects the employees to the danger of illness or disease incident to such work or process, to which employees are not ordinarily exposed in other lines of employment, shall, for the protection of all employees engaged in such work or process, adopt and provide reasonable and approved devices, means or methods for the prevention of such industrial or occupational diseases as are incident to such work or process.

2. Every employer in this State engaged in the carrying on of any process of manufacture or labour in which sugar of lead, white lead, lead chromate, litharge, red lead, arsenate of lead, or Paris green are employed, used or handled, or the manufacture of brass or the smelting of lead or zinc, which processes and employments are hereby declared to be especially dangerous to the health of the employees engaged in any process of manufacture or labour in which poisonous chemicals, minerals or other substances are used or handled by the employees therein in harmful quantities, or under harmful conditions, shall provide for and place at the disposal of the employees engaged in any such process or manufacture and shall maintain in good condition and without cost to the employees, proper working clothes to be kept and used exclusively for such employees, while at work, and all employees therein shall be required at all times while they are at work to use and wear such clothing; and in all processes of manufacture or labour referred to in this section which are unnecessarily productive of noxious or poisonous dusts, adequate and approved respirators shall be furnished and maintained by the employer in good condition and without cost to the employees, and such employees shall use such respirators at all times while engaged in any work necessarily productive of noxious or poisonous dusts.

3. Every employer engaged in carrying on any process or manufacture referred to in Section 2 of this Act, shall, as often as once every calendar month, cause all employees who come into direct contact with the poisonous agencies or injurious processes referred to in Section 2 of this Act, to be examined by a competent licensed physician for the purpose of ascertaining if there exists in any employee any industrial or occupational disease or illness or any disease or illness due or incident to the character of the work in which the employee is engaged.

4. It is hereby made the duty of any licensed physician who shall make the physical examination of employees under the provisions of Section 3 of this Act, to make an immediate report thereof to the State Board of Health of the State of Illinois upon blanks to be furnished by said Board upon request, and if no such disease or illness is found, the physician shall so report, and if any such disease is found, the report shall state the name, address, sex and age of such employee and the name of such employer, and the nature of the disease or illness with which the employee is afflicted, and the probable extent and duration thereof, and the last place of employment: *Provided*, that the failure of any such physician to receive the blanks of the State Board of Health for the making of such report, shall not excuse such physician from making the report as herein provided.

¹ Ohio, Section 6330-1-6330-12, Oct., 1913, reproduced in *The Laws Governing Factory and Building Inspection* 1922, p. 19.

² Pennsylvania, No. 851, 26. 7. 13.

³ Laws of the State of Illinois, pp. 67-77.

5. The Secretary of the State Board of Health shall, immediately upon receipt of any report from any physician in accordance with the provisions of Section 4 of this Act, transmit a copy thereof to the Illinois Department of Factory Inspection.

6. Every employer engaged in carrying on any process or manufacture referred to in Section 2 of this Act, shall provide, separate and apart from the workshop in which such employees are engaged, a dressing room and lavatory for the use of such employees who are exposed to poisonous or injurious dusts, fumes and gases, and such lavatory shall be kept and maintained in a clean and wholesome manner and provided with a sufficient number of basins or spigots, with adequate washing facilities, including hot and cold water, clean towels and soap and shower bath, and the dressing rooms shall be furnished with clothes presses or compartments, so that the ordinary street clothes of such employees shall be kept separate and apart from their working clothes.

7. No employee shall take or be allowed to take any food or drink of any kind into any room or apartment in which any process or manufacture referred to in Section 2 of this Act is carried on, or in which poisonous substances or injurious or noxious fumes, dusts or gases are present as the result of such work or process being carried on in such room or apartment, and the employees shall not remain in any such room or apartment during the time allowed for meals, and suitable provision shall be made and maintained by the employer for enabling the employees to take their meals elsewhere in such place of employment, and a sufficient number of sanitary closed receptacles containing wholesome drinking water shall be provided and maintained for the use of the employees within reasonable access and without cost to them.

8. All employers engaged in carrying on any process or manufacture referred to in Section 2 of this Act, shall provide and maintain adequate devices for carrying off all poisonous or injurious fumes from any furnaces which may be employed in any such process or manufacture, and shall also provide and maintain adequate facilities for carrying off all injurious dust, and the floors in any room or apartment where such work or process is carried on shall, so far as practicable, be kept and maintained in a smooth and hard condition, and no sweeping shall be permitted during working hours except where the floors in such workshop are dampened so as to prevent the raising of dust; and all ore, slag, dross and fumes shall be kept in some room or apartment separate from the working rooms occupied by the employees, and where practicable, all mixing and weighing of such ore, slag, dross or fume shall be done in such separate room or apartment, and all such material shall, so far as practicable, be dampened before being handled or transported by employees.

9. When any flues are used in any such process or manufacture referred to in Section 2 of this Act, and such flues are being cleaned out or emptied, the employer shall in every case provide and maintain a sufficient and adequate means or device, such as canvas bags or other practical device, or by dampening the dust, or some other sufficient method for catching and collecting the dust and preventing it from unreasonably fouling or polluting the air in which the employees are obliged to work, and wherever practicable, the dust occasioned in any process or manufacture referred to in Section 2 of this Act, and any polishing or finishing therein, shall be dampened or wet down, and every reasonable precaution shall be adopted by the employer to prevent the unnecessary creation or raising of dust, and all floors shall be washed or scrubbed at least once every working day; and such parts of the work or process as are especially dangerous to employees, on account of poisonous fumes, dusts and gases, shall, where practicable, be carried on in separate rooms and under cover of some suitable and sufficient device to remove the danger to the health of such employees, as far as may be reasonably consistent with the manufacturing process, and the fixtures and tools employed in any such process or manufacture, shall be thoroughly washed and cleaned at reasonable intervals.

10. All hoppers or chutes or similar devices used in the course of any process or manufacture referred to in Section 2 of this Act shall, where practicable, be provided with a hood or covering, and an adequate and sufficient apparatus or other proper device for the purpose of drawing away from the employees noxious, poisonous or injurious dusts, and preventing the employees from coming into unnecessary contact therewith; and all conveyances or receptacles used for the transportation about or the storage in any place where any such process or manufacture referred to in Section 2 of this Act is carried on, shall be properly covered or dampened in such way as to protect the health of the employees, and no refuse of a dangerous character incident to the work or process carried on in any such place shall be allowed to unnecessarily accumulate on the floors thereof.

11. It shall be the duty of the State Department of Factory Inspection to enforce the provisions of this Act, and to prosecute all violations of the same before any magistrate or any court of competent jurisdiction in this State, and for that purpose such department and its inspectors are empowered to visit and inspect at all reasonable times all places of employment covered by the provisions of this Act. In the enforcement of the provisions hereof the Department of Factory Inspection shall give proper notice in regard to any violation of this Act to any employer of labour violating it, and directing the instalment of any approved device, means or method reasonably necessary, in his judgment, to protect the health of the employees therein, and such notice shall be written or printed and shall be signed officially by the Chief State Factory Inspector or the Assistant Chief State Factory Inspector, and said notice may be served by delivering the same to the person upon whom service is to be had, or by leaving at his usual place of abode or business an exact copy thereof, or by sending a copy thereof to such person by registered mail, and upon receipt of such notice, calling the attention of the employer to such violation, he shall immediately comply with all the provisions of this Act.

12. If any occupational or industrial disease or illness or any disease or illness peculiar to the work or process carried on shall be found in any place of employment in this State by the inspectors of the State Board of Factory Inspection, or called to their attention by the State Board of Health, which disease or illness shall be caused in whole or in part, in the opinion of the inspector by a disregard by the employer of the provisions of this Act, or a failure on the part of the employer to adopt reasonable appliances, devices, means or methods which are known to be reasonably adequate and sufficient to prevent the contraction or continuation of any such disease or illness, it shall be the duty of the Department of Factory Inspection to immediately notify the employer in such place of employment, in the manner provided in Section 12 of this Act, to install adequate and approved appliances, devices, means or methods to prevent the contracting and continuance of any such disease or illness, and to comply with all the provisions of this Act.

13. For the purpose of disseminating a general knowledge of the provisions of this Act and of the dangers to the health of employees in any work or process covered by the provisions of this Act, the employer shall post in a conspicuous place in every room or apartment in which any such work or process is carried on, appropriate notices of the known dangers to the health of any such employees arising from such work or process, and simple instructions as to any known means of avoiding, so far as possible, the injurious consequences thereof and the Chief State Factory Inspector shall, upon request, have prepared a notice covering the salient features of this Act, and furnish a reasonable number of copies thereof to employers in this State, covered by the provisions of this Act, which notice shall be posted by every such employer in a conspicuous place in every room or apartment in such place of employment. The notices required by this section shall be printed on cardboard of suitable character and the type used shall be such as to make them easily legible and in addition to English they shall be printed in such other language or languages as may be necessary to make them intelligible to the employees.

14. Any person, firm or corporation who shall, personally or through any agent, violate any of the provisions of this Act, or who omits or fails to comply with any of its requirements, or who obstructs or interferes with any examination or investigation being made by the State Department of Factory Inspection in accordance with the provisions of this Act, or any employee who shall violate any of the provisions of this Act shall be deemed guilty of a misdemeanor and on conviction thereof shall be punished for the first offense by a fine of not less than ten dollars (\$10.00) or more than one hundred dollars (\$100.00), and upon conviction of the second or subsequent offenses, shall be fined not less than fifty dollars (\$50.00) or more than two hundred dollars (\$200.00), and in each case shall stand committed until such fine and costs are paid unless otherwise discharged by due process of law.

15. For any injury to the health of any employee proximately caused by any wilful violation of this Act or wilful failure to comply with any of its provisions, a right of action shall accrue to the party whose health has been so injured, for any direct damages sustained thereby; and in case of loss of life by reason of such wilful violation or wilful failure as aforesaid, a right of action shall accrue to the widow of such deceased person, his lineal heirs or adopted children, or to any other person or persons who were, before such loss of life, dependent for support upon such deceased person, for a like recovery of damages for the injury sustained by reason of such loss of life, not to exceed the sum of ten thousand dollars: *Provided:* that every such action for damages in case of death shall be commenced within one year after the death of such employee.

Amendment of the above Section 15, July 13, 1921.

Section 1. *Be it enacted by the People of the State of Illinois, represented in the General Assembly:* Section 15 of "An Act to promote the public health by protecting certain employees in this State from the dangers of occupational diseases and providing for the enforcement thereof, approved May 26, 1911, in force July 1, 1911," be, and the same is hereby amended as follows:

(a) *Disablement an accident.*—The disablement of an employee engaged in occupations covered by section two (2) of this Act resulting from an occupational disease arising as a result of the work, labour, manufacture or process referred to in said section two (2), shall be treated as the happening of an accidental injury within the terms and meaning of The Workmen's Compensation Act.

(b) *Definition.*—The term disablement means the state of being disabled from earning full wages at the work at which the employee was last employed by the employer from whom he claims compensation.

(c) *Employee's right to recover compensation.*—If any employee employed in occupations covered by section two (2) of this Act is disabled or dies and his disability or death is caused by a disease arising out of the occupations referred to in section two (2) of this Act, which disease arises out of and in the course of his employment, he or his dependents shall be entitled to compensation for his death or for the duration of his disability in accordance with the provisions of The Workmen's Compensation Act.

(d) *Limitation of right to recover damages.*—No common law or statutory right to recover damages for injury or death sustained by an employee from an occupational disease other than the compensation provided in The Workmen's Compensation Act shall be available to any employees engaged in any work, manufacture or process referred to in section two (2) of this Act, to any one wholly or partially dependent upon him, the legal representatives of his estate or to anyone otherwise entitled to recover damages for such injury.

(e) *Extent of amendment.*—Except as amended herein said section fifteen (15) shall be and remain in full force and effect as heretofore.

Filed July 13, 1921.

16. The invalidity of any portion of this Act shall not affect the validity of any other portion thereof which can be given effect without such invalid part.

Approved May 26, 1911.

In force July 1, 1911.

Amended July 13, 1921.

*Missouri.*¹

The Missouri Act is substantially the same as that of Illinois above, save that no provision is made in the Missouri Act for compensation of occupational diseases.

(c) *New York.*

New York: Rules relating to removal of dust, gases and fumes.²

Rule 721.—Every work or process in the manufacture or use of white lead, red lead, litharge, sugar of lead, arsenate of lead, lead chromate, lead sulphate, lead nitrate or fluo-silicate, or in the manufacture of pottery, tiles or porcelain enameled sanitary ware, including the corroding or oxidizing of lead, and the crushing, mixing, sifting, grinding and packing of all lead salts or other compounds shall be so conducted, and such adequate devices provided and maintained by the employer as to protect the employee, as far as possible, from contact with lead dust or lead fumes. Every kettle, vessel, receptacle or furnace in which lead in any form above enumerated is being melted or treated, and any place where the contents of such kettles, receptacles or furnaces are discharged, shall be provided with a hood so constructed and located that the dust or fumes will be drawn into it, and connected with an efficient air exhaust; all vessels or containers in which dry lead in any chemical form or combination above enumerated is being conveyed from one place to another within the factory shall be equipped, at the places where the same are filled or discharged, with hoods having connection with an efficient air exhaust; and all hoppers, chutes, conveyers, elevators, separators, vents from separators, dumps, pulverizers, chasers, dry-pans, other apparatus for drying pulp lead, dry-pans dump, and all barrel packers and cars or other receptacles into which corrossions are at the time being emptied shall be connected with an efficient dust collecting system. Such system shall be regulated by the discharge of air from a fan, or other apparatus, either through a cloth dust collector having an area of not less than one-half ($\frac{1}{2}$) square foot of cloth to every cubic foot of air passing through it per minute, the dust collector to be placed in a separate room in which no employee shall be required or allowed to enter, except for essential repairs, while the works are in operation; or such other apparatus as will efficiently remove the lead dusts from the air before it is discharged into the outdoor air.

Rule 722.—The employer shall provide, and renew when necessary, at least two (2) respirators of approved type for each employee who is engaged in any work or process which produces lead dusts.

Rule 723.—Duplicate plans or drawings made in ink to scale, or prints of such scale drawings, and specifications, showing location and size of all hoods, main and branch pipes and fans and the kind of work for which they are to be used, may be filed by the owner or contractor with the Commissioner for examination whenever an exhaust system is to be installed, extended or altered, under the rules of subdivisions B, C and D. The employer or contractor, upon completion of any installation, shall notify the Commissioner, and a test to determine its efficiency shall be made by him before the system is approved.

These rules shall take effect May 15, 1915.

(3) **Legislation in individual lead trades**

(a) New Jersey: Regulations for the lead and copper industries³

(Drafted by Lillian Erskine, special investigator, for the New Jersey Department of Labour, approved by Ernst F. Eurich, consulting metallurgical expert for the State, and issued in the form of a circular letter to these trades by Lewis T. Bryant, Commissioner of Labour, 1914.)

The lead and copper industries of the State having been reported upon by our consulting metallurgical expert and special investigator, I desire to call the attention of your company to the sanitary regulations governing these trades, which are approved by the Department of Labour.

I. In view of the dust generated in the handling, sampling and transportation of ores, the department requires that care be exercised to protect the workers by means of a thorough sprink-

¹ Missouri, Occupational Disease Law, 23. 6. 13, Sections 6817-6831, reproduced in Laws, Rules and Regulations covering Industrial Inspection, 1921, pp. 13-18.

² New York Dept. of Labor, Bull. No. 12, May 15, 1915, pp. 7, 8.

³ Lead Poisoning in the Smelting and Refining of Lead, U.S. Bur. Lab. Stats., No. 141, 1914, pp. 85-87.

ling of such ores when practicable; that automatic machine sampling shall be the standard method; that the air of the sampling mill or mills shall be kept free from dust, either by means of sprinkling or efficient mechanical exhaust ventilation; that if no means can be devised to control the dust generated in emptying sacks containing lead ores, the workers engaged in such operation shall be furnished and required to wear an approved type of respirator; that no sacks in which lead or other ores have been shipped shall be cleaned by hand, but that all such sacks shall be cleaned by sanitary mechanical methods; and that all ores containing lead stored in bins shall be dampened before transportation.

II. As the roasting of lead ores, whether in furnaces or sintering machines, or by any other method, may expose the workers to injurious fumes or gases, the department requires that when such danger exists, the points at which such fumes or gases enter the workrooms shall be properly hooded, and the hoods connected with efficient mechanical exhaust ventilation.

III. The making up of charges for the lead-blasting furnaces being recognized as offering special risk to the health of workers engaged therein, the department requires the thorough sprinkling of all materials handled in such charges, to the end that they may be damp when dumped upon the feed floor.

IV. In view of the fact that in the event of the breakdown or repair of any mechanical exhaust system for the control of fumes generated in the various tapping operations of the blast furnaces treating lead ores or leady copper ores, the workers on the feed floor will be exposed to risk if the floor is not tight, the department requires that such feed floors shall be impervious to fume.

V. As dangerous fumes are generated in the tapping operations of lead-blasting furnaces, the department requires the installation of hoods with efficient mechanical exhaust ventilation at all points where, in the tapping operations, fumes are liberated.

VI. To prevent fumes and gases issuing from the charging openings of lead and copper blast furnaces, the department requires flues of a sufficient size, with an efficient natural or mechanical draught, and suitable provision for any accident blocking which may occur, e.g., providing each furnace with a separate stack communicating directly with the air and closed with a damper.

VII. (a) In view of the unsanitary features of hand shaking of bags in the bag house or houses designed for collecting flue dust in lead and copper processes, the department requires the installation of such mechanical method for shaking as shall prevent the exposure of the workers to dusts generated in shaking the bags.

(b) The department further requires the protection of such workers as are exposed to dust in cleaning flues, bag houses, and bag-house cellars by means of the use of special clothing and approved respirators to be furnished them by the employer for such purpose; and urges the enforcement by the employer of rules calling for special sanitary precautions on the part of the workers employed.

(c) As the cleaning of flues, bag house, and bag-house cellars is universally recognized as an employment hazardous to health, the department calls the attention of employers to the foreign practice of shortening the hours of such workers as are directly exposed to flue dust in cleaning processes.

VIII. If in any of the various operations connected with lead refining, lead fumes habitually or from time to time, pass into the air of the workrooms, they shall be removed by means of efficient mechanical exhaust ventilation.

This applies especially to retort furnaces, cupelling furnaces, antimony slag furnaces and lead reverberatory furnaces.

IX. In view of the fact that some copper matte contains lead, arsenic, and antimony, and that in converting copper matte there is always a copious evolution of sulphurous acid gas, the department requires the efficient hooding of all converters, and that such hoods shall effectively remove the fumes and gases generated, whatever may be the position of the converter.

X. (a) To protect the health of the workers, the department requires that the electrolytic tanks be placed in spacious, well-ventilated buildings, and, where necessary, that fresh air shall be continually supplied by means of fans.

(b) The department requires that all liberating tanks shall be so protected that the gas bubble rising to the surface shall not spray the acid solution into the air of the tank rooms.

(c) The department requires that the purifying of the foul electrolytic solutions, and the precipitation of copper from the solutions by means of iron, shall either be carried on in tanks placed under a hood or hoods connected with effective mechanical exhaust ventilation, or that such tanks shall be placed in the open air in such position that the gases given off will be quickly diffused and not be a source of harm.

XI. The department suggests the adoption of air rabbling of the copper refining furnaces, as hand rabbling exposes the worker to excessive heat and glare.

XII. The department urges the elimination of hand charging of the anode and cathode furnaces, to the end that the prevailing mechanical injuries to the workers may be lessened.

XIII. In order that the air of the workrooms in which furnace processes are carried on may be kept free from dust, the department requires that skimmings, drosses, matte, and slag from furnaces shall not be allowed to accumulate on the floors of the workrooms; that all such by-products as produce dust shall be thoroughly sprinkled before transportation; and that no dry sweepings but only wet cleaning shall be permitted in the departments where lead is treated.

XIV. Because of the production of lead oxides, and the possible evolution of lead fumes in the melting of pig lead for trade purposes, or in the manufacture of lead alloys not containing

arsenic, the department requires the protection of all such lead melting and alloy kettles by means of hoods connected with an efficient method of ventilation.

XV. In view of the dangerous character of the fumes liberated in the making of alloys of lead and arsenic, and of the lead oxides and fumes produced in the melting of scrap lead, the department requires the protection of all such lead and arsenic alloy kettles and scrap lead melting kettles by means of hoods connected with efficient mechanical exhaust ventilation.

XVI. In view of the established fact that cleanliness on the part of the workers is an important factor in lessening lead poisoning in all processes in which that metal is handled, and that copper sulphate, to a greater or less degree, gets on the clothes and on the persons of workers in the electrolytic refining of copper, and that all employees in furnace processes and the handling of molten metals are exposed to excessive heat at certain times, the department requires the furnishing of sanitary lockers, dressing room or rooms, and convenient and adequate washing facilities, with shower baths for room or rooms and convenient and adequate washing facilities, with shower baths for all lead and copper employees, and urges upon the management the necessity for a strict enforcement of the use of these washing facilities by the workers.

XVII. Since it is recognized that eating in workrooms contaminated by lead dust or fumes is a menace to the health of the worker, and that the general eating in rooms where metallurgical processes are carried on may, in many cases, be very questionable from a sanitary point of view, the department requires the installation of a sanitary and convenient lunch room, or rooms for the use of all lead and copper employees, and urges upon the management the necessity for a strict enforcement of their use.

The efficient mechanical exhaust ventilation required is fixed by the State's standard of 1912.

Sufficient suction head shall be maintained in each branch pipe within 15 inches of the hoods to raise 2 inches of water column in a U-shaped tube. Pressure to be taken by pressing tube attachment over small opening through pipe, commonly called static method. Tests to be made with all branches open and unobstructed.

(b) New Jersey: Hygienic regulations for printing and typesetting establishments¹

These are the regulations required by the Department of Labour of New Jersey:

Suitable toilet accommodations shall consist of separate toilet rooms for the sexes, properly heated, ventilated either by natural or mechanical means, and provided with a vestibule so as to insure privacy to the users thereof.

One siphon action toilet shall be provided for every 20 persons or fraction thereof. One urinal for each 50 persons or fraction thereof.

Washing accommodations shall be provided on a basis of one hot and one cold water tap for each five persons.

Sanitary steel lockers shall be provided in a clean, heated, and ventilated dressing room. Lockers shall have the following minimum dimensions, it being understood that larger ones may be used if so desired: 60 inches high, 12 inches wide, and 15 inches deep.

Floors of all rooms where lead is used or handled must have smooth, even surfaces so as to permit of thorough cleaning. Floors that are cleaned with a broom must be thoroughly moistened before cleaning.

All floors must be cleaned by a vacuum system where it is impossible to clean with a broom without raising dust.

Dross skimmings from lead pots must be poured into a container provided for this purpose. Plungers must be cleaned either under an exhaust hood or else in a cleaning box.

Gas-pipe joints connected with linotype machines must be examined at least once each day so as to prevent air pollution from gas leaks. Type metal must be cleaned either under an exhaust hood or else by means of a vacuum system.

All lead melting pots, including linotype and monotype pots, stereotype kettles and re-melting kettles, must be equipped with mechanical exhaust hoods. Linotype machines shall be provided with the following exhaust equipment.

Each lead pot shall have a hood with the following dimensions: 10 inches long and 10 inches wide at the largest end. Hood when in position shall hang at a distance no greater than 6 inches above the rim of the melting pot. Hood shall be so constructed as to permit it to slide on the branch pipe to which it is connected. Each hood shall have a suction pipe 4 inches in diameter. Main suction pipe to which all branch suction pipes shall be connected must at all cross-sectional points have an area at least equal to the combined areas of branches at each cross-sectional point.

The exhaust fan must operate at a speed sufficient to generate an air movement in each branch pipe of at least 1,000 linear feet per minute. Tests to be made by placing an anemometer at the end of the branch pipe where it connects with the hood. Entire line must be open and unobstructed when test is made.

Stereotype kettles must be completely hooded in, proper slots and doors being provided, as per detailed blue print, to permit of dross skimming and pump action.

Each hood shall have an 8-inch exhaust pipe in which an air movement of at least 1,000 linear feet per minute shall be generated. Test to be made by placing an anemometer in the branch pipe at the point where it connects with the hood.

¹ Hygiene of the Printing Trades, U.S. Bur. Lab. Stats., Bull. No. 209, 1917, pp. 113-114.

Remelting kettles, where lead slugs are remelted and cast into bars, must be equipped with an exhaust hood of a type to be decided by the type of melting pot. In all cases an air movement of 1,000 linear feet per minute must be generated in the branch pipe leading from the exhaust hood. Test to be the same as in the case of a stereotype kettle.

The fumes passing through the exhaust fan must be discharged outside the workroom at a point where they can not return through openings in the building.

Exhaust systems shall be constructed of galvanized sheet steel in accordance with the following details:

Piping—Diameter—

4 to 10 inches.....	No. 24 gauge.
11 to 18 inches.....	No. 22 gauge.
19 to 26 inches.....	No. 20 gauge.
27 inches and larger.....	No. 18 gauge.
Hoods.....	No. 22 gauge.

Elbows.—One gauge heavier than the pipe to which they are attached.

Riveting.—All straight seams should be riveted with tinned rivets placed on 2½ inch centers. All round seams should be riveted as follows:

Piping—Diameter

4 to 8 inches.....	4 rivets.
9 to 12 inches.....	5 rivets.
13 to 18 inches.....	6 rivets.
19 to 24 inches.....	7 rivets.
25 to 30 inches.....	8 rivets.

All elbows to be riveted on 2½ inch centers.

Soldering.—All seams should be heavily soldered with pure half-and-half solder. The soldering is very important, as it prevents loss of air due to leakage. (Engineers claim that usually 10 per cent. of power loss is due to leakage.) Soldering also prevents corrosion of the edges of the metal which have become exposed by cutting into the stock-sheets.

Edges.—All exposed edges not attached to other metal should be wired. It is especially important to have all hoods wired. This strengthens the hoods and prevents the operators from receiving cuts from raw edges.

Laps.—All piping, etc., should have at least a 1-inch lap, made in the direction of the flow of the air current. This prevents dust clogging and friction loss.

Elbows.—All elbows should be made on a radius of not less than 1½ times the diameter of the elbows. Said radius to be measured from the throat of the elbow. All elbows should be made of hand-swagged riveted sections, and be hand-pounded as smooth as possible.

Collars.—All pipe collars should enter the main pipes at not more than a 45-degree angle, and should be riveted and soldered to the main pipes.

Blast gates.—Every branch pipe shall be fitted with a blast gate, with the slide attached to the gate with a chain.

Telescopic slip joints.—All telescopic slip joints should be made with a wired outer edge, and with felt packing between them to prevent air leakage.

Fan inlet connection.—At the point where the piping connects to the suction side of the exhaust fan, there should be a detachable sleeve so that ready access to the interior of the fan may be had at any time without damaging the piping system.

Automatic fire dampers.—Wherever piping passes through a wall or floor, or from one building to another, an automatic fire damper should be installed. This should be so constructed with balance weights that it remains closed when the fan is not in operation, or will fall shut should fire strike the fusible link holding the balance weight.

(c) **New Jersey: Standard regulations for removing dust generated in the manufacture of pottery¹**

1. Dust generated in the process of manufacturing china ware, lithograph transfer work and electric porcelain ware shall be removed by an exhaust system constructed in accordance with the following details:

II. <i>Artistic china:</i>	Size of pipes
Cleaning green ware.....	6 inches
Cleaning glost ware.....	6 inches

III. *Dumping saggars:* Exhaust table to control flint dust must be provided for this work.

IV. <i>China ware:</i>	Size of pipes
Bedding tables.....	5 inches
Knocking ware—machine constructed according to standard specifications shall have.....	12 inches

¹ Sanitary and Engineering Industrial Standards, New Jersey Department of Labour, September 15, 1919, pp. 34-36.

V. <i>Electric Porcelain ware</i>	Size of pipes
Fettling tables.....	4 inches
Turning lathe (according to work).....	3 or 4 inches
Brushing ware.....	4 inches

VI. *Blowing dust from ware*: Each case to be acted on according to local conditions.

VII. *Blowing glaze on ware*: Detailed plan of exhaust cabinet furnished by Department of Labour.

VIII. <i>Lithograph transfer work</i> :	Size of pipes
Brushing tables.....	5 inches
Dusting machine.....	5 inches
Flouring machine.....	5 inches
Cleaning machine.....	5 inches

Test for lithograph transfer work shall be 1 inch of suction (exception to general rule).

IX. *Test*: Sufficient suction head shall be maintained in each branch pipe within 15 inches of the hoods to displace a minimum of two inches of water column in a U-shaped tube. Pressure to be taken by pressing tube attachment over small opening through pipe, commonly called static method. Tests to be made with all branches open and unobstructed.

X. *Proportion*: The inlet of the exhauster shall be at least 20 per cent. greater in area than the combined areas of the several connections of the hoods, and this increase shall be carried proportionately in the main pipe throughout the entire trunk line. The piping on the outlet of the fan is also to be at least 20 per cent. greater than the combined areas of the several connections to the hoods. The main trunk lines shall be provided with suitable cleanouts not over 10 feet apart and the end of the main trunk line shall be blanked off with a removable cap placed on the end.

XI. Gauges of metal to be used (*see* Table No. 1).

Table No. 1.

<i>Diameter of Pipe:</i>	
8" or less.....	No. 24 gauge
9" to 16".....	No. 22 "
17" to 24".....	No. 20 "
25" to 30".....	No. 18 "
31" up.....	No. 16 "

(d) **Louisiana: Regulations for the use of linotype and other type-casting machines**¹

Title.

AN ACT to promote the health and comfort of employees of newspaper and printing concerns in the State of Louisiana, operating three or more linotype or type-casting machines, etc.

Exhaust fans must be used where linotype is used.

Section 1. Be it enacted by the General Assembly of the State of Louisiana, That hereafter all newspaper and printing concerns operating in the State of Louisiana, using three or more linotype or other type-casting machines, shall be required to install in the room or rooms in which said machines are operated, an exhaust fan or other device of sufficient capacity to keep pure air circulating in said room, and to expel the poisonous metal fumes arising from said linotype machines.

Vent pipes for each machine.

Section 2. Be it further enacted, etc., That all newspaper and printing concerns operating in the State of Louisiana, using three or more linotype or other type machines shall be required to install vent pipes on each machine running from the metal pot to a flue or other aperture leading to the outside of the building.

Penalty for violation.

Section 3. Be it further enacted, etc., That the penalty for the violation of the provisions of this Act shall be a fine of not less than \$25.00, nor more than \$100.00 or imprisonment not to exceed sixty days or both, in the discretion of the Court for each offence; and every fifteen days that elapse without complying with the Act will be deemed a separate offence.

¹ Louisiana, Act 237 of 1912, p. 534, Labor Laws of Louisiana, 1922 Compilation, pp. 80, 81.

(IV) Legislation requiring the reporting of occupational diseases, including lead poisoning

The Ohio law is sufficiently typical.

Ohio: An Act to require the reporting of occupational diseases

(As amended February 4, 1920.)

Be it enacted by the General Assembly of the State of Ohio:

Section 1243-1. Every physician in this state attending on or called in to visit a patient whom he believes to be suffering from poisoning from lead, phosphorus, arsenic, brass, wood alcohol, mercury or their compounds, or from anthrax or from compressed air illness and such other occupational diseases and ailments as the state department of health shall require to be reported, shall within forty-eight hours from the time of first attending such patient, send to the commissioner of health a report stating:

- (a) Name, address and occupation of patient.
- (b) Name, address and business of employer.
- (c) Nature of disease.
- (d) Such other information as may be reasonably required by the state department of health.

The reports herein required shall be made on, or in conformity with, the standard schedule blanks hereinafter provided for. The mailing of the report within the time required, in a stamped envelope addressed to the office of the state commissioner of health, shall be a compliance with this section.

Section 1243-2. The state department of health shall prepare and furnish, free of cost, to the physicians included in the preceding section, standard schedule blanks for the reports required under this Act. The form and contents of such blanks shall be determined by the state department of health.

Section 1243-3. Reports made under this Act shall not be evidence of the facts therein stated in any action arising out of the disease therein reported.

Section 1243-4. It shall furthermore be the duty of the state department of health to transmit a copy of all such reports of occupational diseases to the proper official having charge of factory inspection.

Section 1243-5. Whoever being a physician practising in the State of Ohio, neglects or refuses to make and transmit to the state commissioner of health any report provided for in section 1243-1 of the General Code shall be fined not to exceed one hundred dollars or imprisoned for not to exceed ninety days, or both, but no person shall be imprisoned under this section for a first offence, and the prosecution shall always be as and for a first offence unless the affidavit upon which the prosecution is instituted contains the allegation that the offence is a second or repeated offence.

NOTE.—In addition to the diseases or disabilities provided for in section 1243-1 of the above law, the regulations passed by the Public Health Council on February 27, 1920, provide in Rule 1 for the reporting of "any disease or disability contracted as a result of the nature of the person's employment, including the following diseases and not excluding others:

Anilin poisoning,	Bisulphide of carbon poisoning,	Naphtha poisoning,
Benzine (gasoline) poisoning,	Carbon monoxide poisoning,	Natural gas poisoning,
Benzol poisoning,	Dinitrobenzene poisoning	Turpentine poisoning.

(V) Compensation for occupational diseases, including lead poisoning

The Minnesota law gives a fair idea of the detail of these laws.

Minnesota: Compensation for occupational diseases.¹

Section 67 (1) The disablement of an employee resulting from an occupational disease described in subsection (9) of this section, except where specifically otherwise provided, shall be treated as the happening of an accident within the meaning of part 2 of this Act, and the procedure and practice provided in such part 2 shall apply to all proceedings under this section, except where specifically otherwise provided herein. Whenever used in this section "disability" means the state of being disabled from earning full wages at the work at which the employee was last employed, and "disablement" means the act of becoming so disabled.

(2) If an employee is disabled or dies in his disability or death is caused by one of the diseases mentioned in subsection (9) of this section, and the disease is due to the nature of the corresponding employment as described in such subsection in which such employee was engaged and was contracted therein, he or his dependents shall be entitled to compensation for his death or for the duration of his disability according to the provisions of part 2 of this Act, except as otherwise provided in this section; provided, however, that if it shall be determined that such employee is able to earn wages at another occupation which shall be neither unhealthful nor injurious, and such wages do not equal his full wages prior to the date of his disablement, the compensation

¹ Workmen's Compensation Law, June 1st, 1921.

payable shall be a percentage of full compensation proportionate to the reduction in his earning capacity.

(3) Neither the employee nor his dependents shall be entitled to compensation for disability or death resulting from disease unless the disease is due to the nature of his employment and contracted therein within the twelve months previous to the date of disablement whether under one or more employers.

(4) If an employee at the time of his employment, wilfully and falsely represents in writing that he has not previously suffered from the disease which is the cause of disability or death, no compensation shall be payable.

(5) The total compensation due shall be recoverable from the employer who last employed the employee in the employment to the nature of which the disease was due and in which it was contracted. If, however, such disease was contracted while such employee was in the employment of a prior employer, the employer who is made liable for the total compensation as provided by this subsection, may appeal to the Commission for an apportionment of such compensation among the several employers who since the contraction of such disease shall have employed such employee in the employment to the nature of which the disease was due. Such apportionment shall be proportioned to the time such employee was employed in the service of such employers, and shall be determined only after a hearing, notice of the time and place of which shall have been given to every employer alleged to be liable for any portion of such compensation. If the Commission find that any portion of such compensation is payable by an employer prior to the employer who is made liable to the total compensation as provided by this subsection, it shall make an award accordingly in favour of the last employer, and such award may be enforced in the same manner as an award for compensation.

(6) The employer to whom notice of death or disability is to be given, or against whom claim is to be made by an employee, shall be the employer who last employed the employee during the said twelve months in the employment to the nature of which the disease was due and in which it was contracted, and such notice and claim shall be deemed seasonable as against prior employers.

(7) The employee or his dependents, if so requested, shall furnish the last employer or the Commission with such information as to the names and addresses of all his other employers during the said twelve months, as he or they may possess, and if such information is not furnished, or is not sufficient to enable such last employer to take proceedings against a prior employer under subsection (5) of this section, unless it be established that the disease actually was contracted while the employee was in his employment, such last employer shall not be liable to pay compensation, or, if such information is not furnished or is not sufficient to enable such last employer to take proceedings against other employers under subsection (5), such last employer shall be liable only for such part of the total compensation as under the particular circumstances the Commission may deem just: but a false statement in the information furnished as aforesaid shall not impair the employee's rights unless the last employer is prejudiced thereby.

(8) If the employee, at or immediately before the date of disablement, was employed in any process mentioned in the second column of the schedule of diseases in subsection (9) of this section, and his disease is the disease in the first column of such schedule set opposite the description of the process, the disease presumptively shall be deemed to have been due to the nature of that employment.

(9) For the purpose of this Act only the diseases enumerated in column one, following, shall be deemed to be occupational diseases:

(Twenty-three occupational diseases are listed here, including (column 1), "lead poisoning or its sequelae" incurred (column 2) in "any process involving the use of lead or its preparations or compounds.")

(10) Nothing in this section shall affect the rights of an employee to recover compensation in respect to a disease to which this section does not apply if the disease is an accidental personal injury within the meaning of the other provisions of part 2 of this Act.

(11) The provisions of this section shall not apply to disability or death resulting from a disease contracted prior to the date on which this Act takes effect.

Section 68. All rights and liabilities arising on account of accidents or injuries occurring prior to the taking effect of this Act shall be governed by the then existing law.

Section 69. In case for any reason any paragraph or any provision of this Act shall be questioned in any court of last resort, and shall be held by such court to be unconstitutional or invalid, the same shall not be held to affect any other paragraph or provision of this Act, except that parts 1 and 2 are hereby declared to be inseparable, and if either part be declared void or operative in an essential part, so that the whole of such part must fall, the other part shall fall with it and not stand alone. Except as otherwise expressly provided, part 1 of this Act shall not apply in cases where part 2 becomes operative in accordance with the provisions thereof, but shall apply in all other cases and in such cases shall be in extension or modification of the common law.

Section 70. Chapter 467, general laws Minnesota for 1913, and all Acts amendatory thereof, and all Acts and parts of Acts inconsistent with this Act are hereby repealed; provided, however, that this Act shall not be deemed to repeal chapter 359, Laws of Minnesota for 1919, in so far as the same applies to employers not under part 2 of this Act.

Section 71. This Act shall take effect and be in force from and after the first day of June, 1921.

CHAPTER IV

FRANCE

(I) Scope and analysis of the laws

The following legislation is in force:

- (1) Special regulations for the use of white lead in painting, whether on the exteriors or interiors of buildings. 20. 7. 09.
- (2) Regulations regarding the use of white lead in painting operations. 1. 10. 13.
- (3) Special hygienic measures applicable to industries where the personnel is exposed to lead poisoning. 1. 10. 13.
- (4) Decree concerning industries dangerous for women and children. 21. 3. 14.
- (5) Law extending to occupational diseases the Act of 9. 4. 18, concerning industrial accidents. 25. 10. 19.
- (6) Decree concerning the execution of the above Act. 31. 12. 20.
- (7) Decree concerning (5) above. 4. 5. 21.

The most noteworthy features of the French legislation are (a) the prohibition of the use of white lead in both indoor and outdoor painting of buildings, and (b) the provisions for medical supervision in the trades covered by the law of 1. 10. 13. (Special hygienic measures applicable to industries where the personnel is exposed to lead poisoning.)

The lead trades subject to restrictions

The trades subject to special regulations by the law of 1. 10. 13, are as follows:

Metallurgy,
Silver-lead assaying,
Manufacture of accumulators,
Glass works,
Manufacture of lead enamels,
Application of lead enamels,
Manufacture of pottery,
Decoration of porcelain or earthenware,
Chromo-lithographic ceramics,
Manufacture of alloys, oxides, lead salts and colours.

The reporting of occupational diseases, including lead poisoning

This was made obligatory by the Law of 25. 10. 19 extending the compensation Act to occupational diseases.

Compensation for occupational diseases.

This was provided for by the Law of 25. 10. 19.

(II) Text of the lead laws

- (1) Special regulations for the use of white lead in painting, whether on the exteriors or interiors of buildings¹

(20th July, 1919.)

Art. 78.—In factories, workshops and buildings in course of construction or repair, and, generally, in every work place where painting is being done on buildings, industrial heads, managers, or business heads are required, independently of the measures prescribed by virtue of the first chapter of this heading, to conform to the following requirements:

¹ Articles 78, 79 and 80 of Book II of the Labour Code.

Art. 79.—From the 1st January, 1915, the use of white lead, linseed oil containing lead, or any special product comprising white lead, is prohibited in all painting operations of whatever kind executed by working painters, whether on the exterior or the interior of buildings.

Art. 80.—A regulation of the public administration may specify, if necessary, special operations to which exemption from the preceding provisions may be accorded.

(2) Regulations regarding the use of white lead in painting operations

(Decree of 1st October, 1913.)

Art. 1.—In painting operations, industrial heads, managers, or business heads are required, independently of the general measures prescribed by the decree of 10th July, 1913, to take the special measures of protection and of hygiene set forth in the following articles.

Art. 2.—Where the use of white lead is not prohibited by virtue of articles 78 to 80 of Book II of the Labour and Social Welfare Code, it can only be used in the form of paste.

Art. 3.—It is prohibited to apply directly with the hand any products with a white lead base in painting operations.

Art. 4.—It is prohibited to dry scrape or rub with pumice stone paint containing white lead.

Art. 5.—In the operations of wet scraping and pumicing, and generally in all white lead painting work, industrial heads must place at the disposal of their workmen overalls exclusively reserved for this work.

They shall see to it that these garments are kept in proper condition and often washed.

The necessary means for ensuring cleanliness shall be put at the disposal of the workers in the place in which they work.

Equipment and tools shall be kept in a satisfactory state of cleanliness. Their cleaning shall be done without dry scraping.

Art. 6.—Industrial heads, managers, or business heads are required to post up at the places where workers are hired and paid:

- (1) The text of the present decree;
- (2) A workroom regulation requiring workers to make use of the overalls and the facilities for cleanliness put at their disposal in accordance with Article 4.

Art. 7.—The minimum period allowed for by Article 69 of Book II of the Labour and Social Welfare Code before notification can be sent that the law must now be complied with is specified as follows: 8 days for the peremptory notification based on the provisions of Article 4 (paragraph 1) of this decree; 4 days for the execution of the peremptory notification based on the other provisions.

Temporarily, the time allowed in connection with the notifications sent to heads of establishments before the publication of this decree shall remain the same as those previously specified.

Art. 8.—In pursuance of Articles 3 and 4 of the law of 26th November, 1912, the decree of 18th July, 1902, and the decree of 15th July, 1904, shall cease to be effective from the date of publication of this decree.

Art. 9.—The Minister of Labour and of Social Welfare is charged with the execution of the present decree, which will be published in the *Journal Officiel de la République française* and inserted in the *Bulletin des lois*.

R. POINCARÉ.

By the President of the Republic,
The Minister of Labour and of Social Welfare,
HENRY CHERON.

(3) Special hygienic measures applicable to industries where the personnel is exposed to lead-poisoning.¹

(Decree dated 1st October, 1913.)

In the following lead-working operations—metallurgy, silver-lead assaying, manufacture of accumulators, glass works, manufacture of lead enamels, their application, manufacture of pottery, decoration of porcelain or earthenware, chromo-lithographic ceramics, manufacture of alloys, oxides, lead salts and colours—the heads of establishments, directors or managers, shall be compelled, independently of the general regulations prescribed in the decree of 10th July, 1913, to take special steps for the protection of health, as described in the following sections:

2. Lead melting pots shall be installed in a ventilated room, distinct from other workshops.

Hoods or other arrangements shall be installed for the efficient drawing off of fumes:

- (a) Over the tapping-holes of lead and lead dross in lead works;
- (b) In front of furnace doors in works devoted to the manufacture of lead oxide;
- (c) Above lead or lead-alloy smelting pots in other trades described in regulation 1.

3. It shall be the duty of the heads of establishments, directors or managers to take the necessary steps to ensure that all work on oxides and other compounds of lead, which are liable to give off dust, shall be carried out under the following conditions:

¹ Gilbert Stone, *Laws and Regulations relating to Lead Poisoning*, 1922, pp. 133-136.

These operations shall be carried out, as far as possible, on materials in a wet state;

Whenever such work cannot be carried out in the vicinity of water or of another liquid, it shall be mechanically carried out in an enclosed and dust-proof apparatus;

In the event of it being impossible to conform to the provisions of one or other of the two preceding paragraphs, the work in question shall be carried out under a strong exhaust fan blast so arranged that noxious substances shall be intercepted in apparatus suitably arranged for the purpose;

Finally, should neither of the above systems be practicable, mask respirators shall be placed at the disposal of the workers.

4. Oxides or other lead compounds, whether in a dry or wet state, in suspension or in solution, shall never be handled with bare hands. For these operations, the head of the establishment shall be compelled to place at the disposal of his staff, either gloves of waterproof material, such as india-rubber, or suitable tools, and shall see that these are maintained in a proper state of repair and are frequently cleaned.

5. Tables on which these products are handled shall be covered with a water-proof material, which shall be maintained in a perfectly waterproof condition.

The same regulations shall apply to the flooring of workshops, which shall, moreover, slope slightly towards a watertight sump, in which substances containing lead shall be collected.

Workshop floors shall be kept moist.

The work shall be so arranged that there shall be no splashing of liquid. Tables, floors and walls shall be washed at least once a week.

6. Without prejudice to the provisions stipulated in regulation 3, the grinding of lead products, their mixing and use in a powdered state, shall be carried out in special rooms, which shall be very efficiently ventilated.

Should it be impossible to dampen the materials, respiratory hoods shall be placed at the disposal of the workers.

7. The dipping of pottery with the bare hand into solutions containing litharge, red lead, galena, white lead in suspension, shall be prohibited.

8. The bringing into the workshops of any food or drink shall be prohibited.

9. The heads of establishments shall be compelled to place at the disposal of the staff overalls or clothes exclusively reserved for working operations independently of the gloves and respiratory masks.

They shall be compelled to maintain these articles in a satisfactory condition.

10. In establishments in which the staff is exposed to the danger of lead poisoning, lavatory cloakrooms shall be provided, separate and distinct from those rooms in which lead dust or fumes are liberated.

Lavatory cloakrooms for the use of workmen exposed to lead dust or fumes shall be provided with a sufficient number of washing basins or taps, with an abundant supply of water, and also of soap, and each worker shall be provided with a towel, which shall be changed at least once a week. Cupboards or lockers, fitted with locks or padlocks, shall also be provided, and so arranged that the ordinary clothes are separated from the working clothes.

11. A warm bath or a shower bath shall be placed, once a week, at the disposal of the staff exposed to lead dust or fumes.

A warm bath or a shower bath shall be placed, every day, at the disposal, after work, of every workman engaged on any of the following occupations: Emptying or cleaning condensing chambers and flues, repairing furnaces in lead works, conveying lead from the pits in white lead works, packing red lead into barrels, or finally, reducing lead enamels to powder, and dry-grinding.

12. Heads of establishments shall be compelled to post up the following in a prominent position, in the workrooms:

(1) The text of the present decree;

(2) A workshop regulation enacting: that workers shall make use of tools, gloves, respirator-masks, and working clothes, placed gratuitously at their disposal; that they shall introduce neither food nor drink into the workshops; that they shall take the greatest care, before each meal, to cleanse thoroughly mouth, nostrils, and hands; that, daily, or once a week, they shall take the baths referred to in regulation II.

13. Heads of establishments, directors or managers shall be compelled to provide medical aid, under conditions defined as below.

14. A medical man, appointed by the head of the establishment, shall undertake examination, and make out reports, as contemplated in regulations 15 and 16.

The firm shall pay for this medical attendance.

15. No worker may be permitted to undertake any work, as contemplated in regulation 1, unless provided with a certificate, issued by the medical man, to the effect that he shows no symptoms of lead poisoning, or of any illness which is liable to be dangerously aggravated by lead poisoning.

16. No worker shall be kept on the same class of work unless the certificate is renewed one month after engagement, and afterwards once a quarter.

In addition to the periodical visits, the head of the establishment shall be compelled to have any workman examined by the medical man if such workman states that he is indisposed

by reason of the work on which he is engaged, or expresses the wish to be subjected to a medical examination.

17. A special register, which shall always be kept up to date, and placed at the disposal of the labour inspector, shall contain for each worker:

- (1) The dates and periods of absence on account of any illness whatever;
- (2) The dates of the certificates produced as justification of these absences, the medical notes contained therein, and the name of the medical man by whom they are issued;
- (3) Reports issued by the medical man of the establishment, in virtue of regulation 15 and 16 above.

18. By Order, issued in consultation with the consultative committee of Arts and Manufactures, the Minister of Labour and Social Welfare may grant to a concern, for a definite period, exemption from all or part of the provisions of regulation 2 (paragraphs *a, b, c*) of regulation 5 (paragraph 2), of regulation 6 (paragraph 1), in the event of the fact being recognized that the application of these provisions is practically impossible, and that the health and safety of workers are assured under conditions at least equivalent to those stipulated in the present decree.

19. The minimum time limit, contemplated in regulation 69 of Book II, of the Code of Labour and Social Welfare, for the enforcement of these regulations, is fixed as follows:

At one month for the enforcement of the following regulations of the decree: regulation 2, regulation 3, regulation 5 (paragraph 2), regulation 10 (paragraph 1);

At fifteen days for the enforcement of the regulations of regulation 5 (paragraph 1);

At eight days for the enforcement of the regulations contained in regulation 9 (paragraph 1);

At four days for the enforcement of the other regulations; nevertheless, this minimum time limit shall be extended to one month for the enforcement of the regulations contained in regulation 6 (paragraph 1) whenever the carrying out of these regulations shall involve the erection of new installations and not only the use of existing installations;

The time limits, which apply to the enforcement of requirements already notified to heads of establishments, before the publication of the present decree, shall be temporarily maintained in so far as these time limits have been previously determined.

20. In virtue of sections 3 and 4 of the Act of 26th November, 1912, the decree of 23rd April 1908, and the decree of 28th December, 1909, shall cease to apply from the date of publication of the present decree.

21. The Minister of Labour and Social Welfare shall be responsible for the enforcement of the present decree, etc.

(4) Decree concerning industries dangerous for children and women

(21st March, 1914)

Extracts relating to lead work.

Art. 13.—In establishments where the varieties of work specified in Table A appended to this decree are carried on, admission to the premises assigned to these operations is prohibited to children under 18, and to women.

Excerpts from Table A.—Operations relating to lead.

Gold- or silver-smiths' ashes, treatment of, by lead.
 White lead, manufacture of.
 Chloride of lead, foundries for.
 Lace, bleaching of by white lead.
 Lead, smelting and rolling of.
 Litharge, manufacture of.
 Massicot, manufacture of.
 Minium, manufacture of.
 Treatment of ores of lead, zinc and copper, for the extraction of the crude metals.

Art. 14.—In establishments where the operations specified in Table B appended to this decree are carried on, admission to the premises assigned to the following operations is prohibited to children under 18.

Excerpts from Table B.—Operations relating to lead.

Electric accumulators (storage batteries) (melting of lead and manipulation of oxides of lead in the manufacture of)
 . Ceramic chromo-lithography (dry powdering and dusting off of colours).

Art. 15.—In the places specified in Table C appended to this decree the work of children under 18, and of women is only permitted under the conditions set forth in the said table.

Excerpts from Table C.—Operations relating to lead.

Electric accumulators (melting of lead and manipulation of oxides of lead in the manufacture of).

Conditions.

From the expiration of the period allowed for the execution of the special rules no woman of any age can be employed in these operations, unless the measures laid down by the rules have been put into operation.

Chromo-lithography.

Conditions.

Children under 16 must not be employed at bronzing by machines.

Ceramic Chromo-lithography (dry powdering and dusting off the colours).

Conditions.

No woman of any age may be employed at this work if dust is given off in the workrooms.

Enamel (application of) on metals.

Conditions.

Children under 18 and women must not be employed in workrooms where the materials are ground and sifted.

Enamels, manufacture of, with non-smoke-consuming furnaces.

Conditions.

Same as above.

Pottery, manufacture of.

Conditions.

Children under 18 must not be employed in workrooms where grinding and sifting is carried on.

Tin-foil.

Conditions.

Children under 16 must not be employed at hand bronzing of tin-foil.

Porcelain, manufacture of.

Conditions.

Children under 18 must not be employed where dust is freely liberated in the workrooms.

Earthenware, manufacture of, with non-smoke-consuming furnaces.

Conditions.

Same as above.

Sheet Iron and Japanned Metals.

Conditions.

Children under 18 and women must not be employed in workshops where poisonous materials are used.

(5) Law extending to occupational diseases the Act of April 9, 1898, concerning industrial accidents

(Act of 25th October, 1919)

The Senate and the Chamber of Deputies have enacted and the President of the French Republic promulgates the following Act:

SECTION I.

The legislation concerning liabilities for industrial accidents is extended to occupational diseases except for the special provisions of the present Act.

SECTION II.

Acute and chronic affections mentioned in the tables annexed to the present Act are considered as occupational diseases when the persons contracting them are workmen habitually

engaged in corresponding industrial works. The nomenclature of occupational diseases, to which the present Act applies, may be increased and the tables annexed to the present Act may be revised and completed by subsequent Acts.

SECTION III.

When the workman leaves one of the industries subject to the present Act his employer remains liable for occupational diseases corresponding to that industry, if that workman contracts them within a period specially provided for each of these affections in the tables mentioned in the preceding section.

This liability, however, decreases in proportion to the time elapsing between the departure of the workman and the time when an incapacity for work occurs as a result of the disease and when that incapacity is entitled to an indemnity.

If at that time the workman is working in another business also classified among the industries corresponding to the said disease, his new employer is liable only for the excess of the indemnity provided by Sections III and IV of the Act of April 9, 1898.

Nevertheless, if it is proved that one of the employers has committed an inexcusable fault which may have affected the health of the victim, the Court may increase his share of liability.

The last of the employers liable will be bound, as regards the victim or those claiming through him, for the whole indemnity saving his recourse against the preceding employers.

SECTION IV.

Any manufacturer having made, in the forms provided by a regulation of public administration, a declaration that his processes of work no longer require the use of substances capable of causing the occupational diseases contemplated by the present Act, shall no longer be subject to the obligations of this Act.

He remains, however, liable during the period of liability provided for as regards his industry and under the conditions mentioned in the preceding section for the occupational diseases which might affect the workmen who were in his employ before the filing of his declaration.

Any declaration from the head of a business found to be knowingly false will make him liable to a fine of not less than one hundred and not more than five thousand francs (from 100 to 5,000 francs) and to imprisonment of not less than three days and not more than one month.

SECTION V.

Any occupational disease for which the victim claims compensation in pursuance of the present Act must be declared by him or under his instructions within fifteen days following the cessation of work, to the mayor of the "commune" who is to make an entry of it and deliver immediately an acknowledgment of it. A medical certificate showing the nature of the disease and its probable consequences must accompany this declaration, the form of which shall be determined by a decree. A certified copy of this declaration is to be transmitted at once by the mayor to the head of the business which employed the sick workman, and to the departmental work inspector or to the (government) civil engineer, in charge of the supervision of the business.

The period of limitation provided for by section 18 of the Act of April 9, 1898, runs from the day of the declaration.

SECTION VI.

The operations of the "Caisse Nationale d'Assurances" against accidents created by the Act of July 11, 1868, are extended to the risks specified in the present Act for occupational diseases which have caused death or permanent disability, total or partial. Within the six months following the promulgation of the present Act, or subsequent Acts, within the meaning of section 11, corresponding scales of compensation shall be prepared by the "Caisse Nationale d'Assurances" against accidents and approved by a decree rendered on the report of the Minister of Labour and Social Welfare and of the Minister of Finance.

These scales shall be calculated in such a way that the risks and general expenses of administration of the "Caisse" are completely met, without it being necessary to have recourse to the subsidy provided by the Act of July 11, 1868.

SECTION VII.

Debtors wishing to pay in one sum may deposit the capital which will correspond with the pensions granted in pursuance of the present Act, with the "Caisse Nationale des retraites" which shall draw up, for the purpose, a scale taking into account the death rate of the victims of occupational diseases and of that of the persons claiming through them; this scale may be modified according to the result of experience.

Until this scale is drawn up, however, the valuation of the capital sums to be deposited shall be made in accordance with the tariffs used for the incomes governed by the Act of July 20, 1886. The transitory period during which these tariffs may be applied shall not exceed five years beginning with the coming into force of the present Act.

SECTION VIII.

A regulation of public administration shall determine the special conditions governing the operation of the syndicate of protection which concurrently with insurance companies may protect employers against the risks contemplated by the present Act.

SECTION IX.

The terms of section 25 of the Act of April 9, 1898, and of section 4, paragraph 2, of the Act of April 12, 1906, amended by the Act of May 29, 1909, are extended to the heads of business subject to the present Act.

SECTION X.

It is the special duty of the High Commission on occupational diseases to give its advice as to the modification to be made in the tables provided for in Section 2, as to the extensions to be given to the present Act, and as to questions of a medical or technical character which may be submitted to it by the Minister of Labour.

It is composed:

1. Of two senators and three deputies elected by their colleagues;
2. Of the general manager of the "Caisse des dépôts et consignations";
3. Of the Director of Labour;
4. Of the Director of Insurance and Social Welfare;
5. Of the Director of Commercial and Industrial Affairs in the Ministry of Commerce;
6. Of the Superintendent of Private Insurance;
7. Of two members of the Academy of Science nominated by their colleagues;
8. Of two members of the Academy of Medicine nominated by their colleagues;
9. Of two professors of the Academy of Medicine nominated by the Faculty;
10. Of two physicians members of the Commission of Industrial Hygiene, nominated by the said Commission;
11. Of two members of the Consultation Committee on Insurances against industrial accidents, nominated by the Committee;
12. Of two members elected by the Boards of Trade;
13. Of one "conseiller prud'homme" an employer and of one "conseiller prud'homme" a workman, of two employers and of two workmen chosen by the High Council of Labour;
14. Of five persons especially competent in the matter of occupational diseases;
15. Of two managers or directors of Mutual Insurance Societies, of Syndicates of protection against occupational diseases;
16. Of two managers or directors of joint-stock companies or limited partnerships insuring against occupational diseases.

In each case there shall be added to the Commission two employers and two workmen representing the industries which are the subject of the discussion.

A decree is to determine the mode of appointment and renewal of members as well as the designation of the president and secretary.

SECTION XI.

Whoever by threats, gifts, promise of money, return of medical fees or supply of remedies made to the victims of industrial accidents, to syndicates or associations, to heads of business, to underwriters, or to any other person, shall have induced or tried to induce the victims of industrial accidents or occupational diseases to resort to a medical clinic or office, or chemist's shop and shall have interfered or tried to interfere with the liberty of the workman in choosing his physician or his chemist, shall be punished by a fine of not less than 100 and not more than 500 francs and by imprisonment for not less than three days and not more than three months.

Section XII

With a view to the prevention of occupational diseases and to the subsequent extension of the present Act, the declaration of any disease having an occupational character and included in a list established by decree after consultation with the High Commission is compulsory for any physician or "officier de santé" who may recognize its existence.

This declaration is to be sent to the Minister of Labour through the work inspector and the civil engineer, and is to show the nature of the disease and that of the victim's occupation and is to be made on cartes-lettres detached from a book of forms furnished gratuitously to the physicians. These cartes-lettres are mailed post-free.

SECTION XIII.

The provisions of the present Act shall come into force fifteen months after its promulgation. The provisions of Section 12, however, shall be applicable one month after the promulgation of the decree mentioned in the said section.

Subsequent amendments and additions provided for in section 2 shall take effect within three months calculated from the promulgation of the subsequent Acts contemplated in the said section and increased by the duration of the liability pertaining to each of the diseases.

The present Act discussed and enacted by the Senate and the Chamber of Deputies shall be executed as an Act of the State.

Done in Paris the 25th of October, 1919.

Signed: R. POINCARE.

By the President of the Republic.

The Minister of Labour and Social Welfare.

COLLIARD

The Minister of Finance,

L. L. KLOTZ.

TABLE OF INDUSTRIAL WORKS SUBJECT TO THE PRESENT ACT AND OF OCCUPATIONAL DISEASES CAUSED BY THEM.

1. OCCUPATIONAL SATURNISM.

(Diseases caused by lead and its compounds.)

Period of liability: one year.

Diseases caused by saturnine intoxication

Lead colic.
Myalgias and arthralgias.
Paralysis of the extensors.
Saturnine hysteria.
Nephritis.
Saturnine gout.

Industrial works capable of causing workmen's saturnine intoxication.

1. Metallurgy and refining of lead.
2. Melting, rolling and fitting of lead and its alloys.
3. Casting of lead alloy, printing types.
4. Manufacture of so-called pewter utensils made of lead alloy.
5. Soldering by means of lead alloy.
6. Operating of type-setting machines using an alloy of lead.
7. Tinning by means of an alloy of lead.
8. Casting of toys made of an alloy of lead.
9. Manufacture of metallic capsules for bottles made of an alloy of lead.
10. Unsoldering of old cans.
11. Handling of printing-types made of an alloy of lead.
12. Manufacture of lead salts (white lead, minium, litharge, chromate of lead).
13. Grinding of colours with a base of lead.
14. Painting of every kind necessitating the use of colours containing lead.
15. Manufacture of lead storage batteries.
16. Manufacture of driers and varnishes containing lead.
17. Manufacture of pottery and earthenware using glazes containing lead.
18. Decoration of porcelain by means of ingredients containing lead.
19. Enamelling of metals by means of enamels containing lead.
20. Varnishing or lacquering by means of enamels containing lead.
21. Dyeing by means of colours containing lead.
22. Polishing of mirrors by means of putty (oxide of lead or tin).

- (6) Decree concerning the regulation of public administration for the execution of the Act of October 25, 1919, extending to occupational diseases the Act of April 9, 1898, on industrial accidents

(Decree of 31st December, 1920)

The President of the French Republic on the report of the Minister of Labour considering the Act of October 25, 1919, extending to occupational diseases the Act of April 9, 1898, concerning industrial accidents and especially its section 4, worded thus: "Any manufacturer having declared in the forms provided by a decree of public administration that his processes of work no longer

require the use of substances capable of causing the occupational diseases contemplated by the present Act, shall no longer be submitted to the obligations of this Act."

Considering the advice of the High Commission on occupational diseases:

The "Conseil d'Etat" heard

Decrees as follows:

SECTION I.

Any manufacturer who ceases to employ processes of work necessitating the use of substances capable of causing the occupational diseases contemplated in the Act of October 25, 1919, must declare it by registered letter with acknowledgment addressed to the departmental inspectors of work, in whose district his business is situated. That declaration shall be made out in accordance with form 1 annexed to the present decree.*

SECTION II.

With a view to establishing the list of businesses subject to the Act mentioned above in accordance with the tables annexed to it, the manufacturers who employ processes of work requiring the use of substances capable of causing the occupational diseases contemplated in the said Act must declare it by registered letter, with acknowledgment, addressed to the inspector of work above mentioned before the opening of the factory. Concerning the industries already at work at the time of the coming into force of the said Act, this declaration must be made before the 27th of January.

This declaration shall be made out in accordance with form II annexed to the present decrees.* The list above mentioned shall be kept posted up by the departmental work inspector who shall moreover enter in it under the heading of each concern subject to the Act, the declarations of cessation mentioned above in Section 1.

SECTION III.

The heads of businesses mentioned in the preceding Section must enter on a special book the surnames, names and addresses of the workmen beneficiaries under the Act of October 25, 1919, in their employ, the nature of the work in which the latter are affected, the dates of their hiring and of their dismissal, and, if certificates of work, such as provided by Section 24 of Title 1 of the Code of Work, have been produced to them (the employers), the name of the preceding employer with whom the workman worked.

That book shall always be kept on the premises at the disposal of the inspector.

Art. 4.—The workman a victim of an occupational disease is to provide as a complement to the declaration mentioned in Art. 5 of the Act of October 25, 1919, information as to the concerns in which he worked during the year preceding his disease. He is to add to it, as far as possible, a copy certified by himself of the certificates delivered to him by the heads of the said concerns in conformity with Act 24 of the Title 1 of the Code of Work.

Art. 5.—The Minister of Labour is charged with the execution of the present decree which shall be published in the "Journal Officiel" of the French Republic and inserted in the "Bulletin des Lois."

Done in Paris, the 31st of December, 1920.

(7) Decree extending to occupational diseases the Act of April 9, 1898, on industrial accidents (Application of section 12 of the Act of October 25, 1919)

(4th May, 1921)

The President of the French Republic,

Considering Section XII of the Act of the 25th of October, 1919, extending to occupational diseases the Act of the 9th of April, 1898, on industrial accidents:

Considering the Act of Finance of the 30th of April, 1921;

Considering the advice of the High Commission on occupational diseases;

On report of the Minister of Labour:

Decrees as follows:

Section 1.—Cases of occupational diseases which doctors in medicine and "officiers de santé" must declare in accordance with the provisions of Section XII of the Act of the 25th of October, 1919, extending to occupational diseases the Act of the 9th of April, 1898, on industrial accidents, are the following:

*Not reproduced here.

(A) All cases of occupational saturnine intoxication and especially

1. Lead colic,
2. Saturnine rheumatism,
3. Saturnine anæmia,
4. Saturnine paralysis,
5. Saturnine encephalopathy,
6. Saturnine nephritis,
7. Saturnine gout,
8. Saturnine amaurosis,
9. Saturnine arteriosclerosis,
10. Saturnine cirrhosis of the liver,
11. Saturnine trembling,
12. Saturnine cachexy.

(B) All cases of occupational mercurial intoxication.

Art. 2. The Minister of Labour is charged with the execution of the present decree which shall be published in the "Journal Officiel" of the French Republic.

Done in Paris, the 4th day of May, 1921.

Signed: A. MILLERAND,
by the President of the Republic,
The Minister of Labour,
DANIEL VINCENT.

CHAPTER V

GERMANY

(I) Scope of the lead laws

The following legislation is in force:

(1) Regulations concerning the erection and management of printing works and type foundry works, 31. 7. 97.

(2) Regulations for lead smelting works, 16. 6. 05.

(3) Regulations for carrying on the industries of painting, distempering, white washing, plastering or varnishing, 27. 6. 05.

(4) Notification relating to the establishment and management of works where the manufacture of electric accumulators from lead or lead compounds is carried on. 6, 5, 08.

(5) Regulations respecting the installation and working of zinc-smelting works and zinc-ore roasting works. 13. 12. 12.

(6) Order respecting the installation and working of establishments for the manufacture of lead colours and other lead compounds (white lead, chromate of lead, lead sulphate, massicot, litharge, red lead, peroxide of lead, English yellow, Neapolitan yellow, acetate of lead, etc.). 27. 1. 20.

(7) Regulations for the manufacture of ceramic transfer pictures.

(8) Notice to file-cutters. 11. 4. 07.¹

In general the type of legislation is very similar to that of Great Britain. Rather more point is made of the necessity of having "level, firm and impervious" floors and "smooth and impervious" walls, and the regulations for medical supervision are more arduous. These latter are the outstanding features of the German legislation.

Service Instructions for the Medical Examination of Lead Workers

These instructions, issued on January 27, 1920, in pursuance of the order for the manufacture of lead colours and other lead compounds, are to be found at the end of the text of this order. They indicate grounds for

(a) rejection of applicants in lead works, and

(b) exclusion or suspension from certain processes.

(a) The grounds for rejection are as follows:

"The medical practitioner must regard as unfit for employment any person who has already suffered severely from lead poisoning (*e.g.*, lead paralysis, serious or repeated attacks of lead colic) or who still shows symptoms of lead poisoning, however slight, or who, owing to the nature of his previous employment, must certainly have absorbed lead, and in whose case the present medical observations and the blood-test—especially the presence of numerous basophil granules in the red cells—indicate that the appearance of lead poisoning in the near future is to be feared. Weak or ailing persons must also be regarded as unsuitable, especially those suffering from pulmonary tuberculosis, from diseases of the circulatory system or of a syphilitic nature, or from inflammation of the kidneys, and persons addicted to drink."

Compensation for lead poisoning

The Workmen's Compensation laws allow compensation for lead poisoning.

¹ These are recommendations only.

Gist of regulation	Manufacturing of lead colours and other lead compounds	Manufacturing of electric accumulators	Painting, distemping, whitewashing, plastering, varnishing	Lead smelting	Zinc smelting and zinc-ore workers
Examination and supervision of health of workers to be entrusted to a qualified medical practitioner	"	"	"	"	"
Every worker to be examined by the medical practitioner before engaged, and informed of danger of lead poisoning.	"				"
Only those workers engaged whom medical practitioner declares to have no predisposition to lead poisoning, or to be in a suitable state of health for such employment.	"	"			"
Certificate of fitness required for certain processes.		"		"	"
Workers inspected periodically.	Bi-monthly in establishments where white lead, sulphate, litharge or red lead manufactured. Monthly in lead smelting, storage battery manufacture, and zinc smelting and zinc ore roasting. Quarterly in establishments where chromate of lead, massicot, peroxide of lead, English yellow, Neapolitan yellow, and acetate of lead are manufactured. Bi-yearly in painting.	Monthly	Bi-yearly	Monthly	Monthly
Workers showing signs of lead poisoning suspended or excluded from certain processes.	"	"	"	"	"
Special register to be kept showing results of examinations, dates of illness, etc.	"	"	"	"	"
Service instructions for the medical examination of lead workers.	"				

(II) Text of the lead laws

- (1) **Regulations of the Imperial Chancellor of Germany, of July 31, 1897, concerning the Erection and Management of Printing Works and Type-founding Works, amended by the Regulations of July 5, 1907, and Those of December 22, 1908¹**

On the basis of paragraph 120 (e) of The Factory Act, the Bundesrath has decided upon the following regulations:

1. The following regulations are to be in force for workrooms in which persons are employed in setting up type or in stereotyping:

(1) The floor of the workroom must not be more than half a meter (1.64) feet below the roadway. Exceptions may be permitted if, with satisfactory isolation of the site and provision for sufficient light and air, health requirements are otherwise observed.

Rooms underneath a roof can only be made use of as workrooms if the roof is lined with wood or plaster.

(2) In workrooms wherein type or stereotype plates are made the air space must be such that each employee shall have at least 15 cubic meters (529.7 cubic feet). In rooms in which persons are employed in other processes at least 12 cubic meters (423.8 cubic feet) of air space must be provided.

In cases of temporary exceptional exigency the higher administrative authorities may on request of the undertaker permit during a maximum period of 30 days, the air space of the workrooms to be utilized in a more intensive manner, requiring, however, at least 10 cubic meters (353.1 cubic feet) to each employee.

(3) The workrooms must be at least 2.6 meters (8.53 feet) high when 15 cubic meters (529.7 cubic feet) of air space are allowed to each person; in all other instances they must be 3 meters (9.84 feet) in height.

The rooms must be provided with windows in sufficient numbers and size to obtain the maximum of light in all places where work is carried on. The windows must be so constructed as to allow of being opened for the purpose of ventilation.

Workrooms with a slanting ceiling must have an average height, as mentioned in the first part of this paragraph.

(4) The workrooms must be provided with hard and non-porous floors, so as to permit moistening for the ready removal of dust. If the floors are of wood they must be well planned and non-absorbent.

Where the walls and ceilings are not paneled or painted with oil they must be whitewashed at least once a year. Paneled and oil-painted walls must be washed at least once a year; oil-painted walls if varnished must be revarnished at least once in every 10 years, and if not varnished must be repainted every 5 years.

The typesetters' stands and the shelves used for the cases which hold the type must either be so fixed to the floor that no dust can accumulate below them, or they must be provided with such high feet that the floor beneath them can be easily cleaned.

(5) Workrooms must be thoroughly ventilated at least once a day. Care must also be taken that a sufficient change of air is obtained during the working hours.

(6) The melting pots for type and stereotype metal must be provided with proper exhausts and hoods.

The fusion of mixed type metals and the remelting of scums must be carried on in special workrooms. If these do not exist, employees not concerned in this work must be excluded while it is being done.

(7) The workrooms and all furnishings, but especially walls, shelves, and window sills, must be thoroughly cleaned at least twice a year.

The floors must be thoroughly cleaned once a day, either by washing or by mopping, so as to keep them free from dust.

In the case of wooden floors or where there is linoleum treated with an absorbing oil (a non-drying oil), washing may be dispensed with, but a daily sweeping will be necessary. The treatment with oil must be renewed in the case of wooden floors at least every eight weeks and in the case of linoleum covered floors at least every two weeks.

(8) Type cases must be cleaned before being used and as long as they are being used must be cleaned at least twice a year.

The dusting of these cases must be done in the open air by means of bellows, and must not be attempted by young persons.

(9) Spitting on the floor is forbidden. Spittoons containing water must be provided in the ratio of one for every five men.

(10) For typesetters as well as for type founders, polishers, and grinders, there must be provided either in the workrooms or in suitable rooms close at hand sufficient washing conveniences, including soap and one clean towel for each person at least once a week.

If there is no running water, there must be one washstand for at least every five workmen. The water must be of sufficient quantity, and there must be means of emptying it.

¹ Hygiene of the Printing Trades, U.S. Bur. Lab. Stats., Bull. No. 209, 1917, pp. 117, 118.

Employers must exercise strict vigilance that no food is taken into the factory, and they must see that no man leaves without first having had a wash.

(11) Wearing apparel which is not worn during working hours must be kept outside of the workrooms. The keeping of such apparel within the workrooms is permitted only in lockers or in cupboards protected from dust by tightly fitting curtains. During working hours these lockers and cupboards must be kept closed.

(12) All lighting arrangements which give rise to considerable heat must be provided with necessary exhausts.

(13) Employers must draw up regulations for the carrying out of paragraphs 8, 9, 10 and 11. In any factory where there are 20 or more workmen employed, the above rules must be incorporated with the regulations of the factory.

II. In every workroom there shall be hung a notice signed by the local authority, stating:

- (a) The length, breadth, and height of the workroom;
- (b) The cubic capacity of the room;
- (c) The number of men allowed to work in the room.

In every workroom there must be, in addition, a notice printed in large type giving the regulations under No. 1.

III. Exemptions from the regulations under No. 1 may be granted by the administrative authorities when there are not more than five workmen employed.

IV. The above regulations come into force immediately for all new factories.

For all factories which are in operation at the time of the announcement paragraphs 5, 7, and 9 of No. 1 come immediately into force and the remainder a year after the publication of the regulation.

(2) Regulations for Lead-Smelting Works (June 16, 1905)¹

General regulations.

1. Workrooms in which lead ores are roasted, sintered or smelted, pig lead produced and submitted to further treatment, distillation of rich lead (bullion cupellation, litharge, red lead, or other oxides of lead prepared, ground, or sieved, or packed, or zinc skimmings distilled, shall be roomy, high and so arranged that a sufficient constant exchange of air takes place. They shall be provided with a level and solid floor to allow of easy removal of dust by a moist method.

The walls shall be smooth, so as to prevent collection of dust; they shall be either washed down or limewashed at least once a year.

Provided, That this shall not apply in the case of calcining sheds with wooden walls.

2. An abundant supply of good drinking water, protected against contamination from dust, shall be provided for the workers on the furnaces, and smelting pots, and in such close proximity to them that they can obtain it at any time without having to go into the open air.

Arrangements for sprinkling the floors shall be provided near the furnaces. The floors of the rooms mentioned in paragraph 1 shall be wet cleansed at least once daily.

3. Prepared (*i.e.*, concentrated) lead ores and leady smelting products, unless moist, shall not be crushed except in an apparatus so arranged as to prevent as far as possible penetration of dust into workrooms.

Provided, That this shall not apply to calcined material from converters.

Sacks in which lead ores and materials containing lead have been packed shall not be freed from dust and cleaned except in a dust-proof apparatus or by washing.

(4) Materials containing lead for charging the blast furnaces, if they are oxides and form dust, shall be damped before they are mixed with other materials, stocked on the feeding floor, or charged into the blast furnaces.

Provided, That this shall not apply in the case of calcined material from converters.

5. Dust, gases, and lead fumes escaping from furnaces and converters, tapping spouts, tapping pots, drain sump, slag pots, slag cars, or slag channels and from glowing residues taken from the furnaces shall be caught as near as possible to the point of origin and removed harmlessly.

Dust-collecting chambers, flues, as well as furnaces which have been "blown down" shall not be entered by workmen unless sufficiently cooled and ventilated.

Special regulations for such parts of a factory where lead colours are prepared.

6. In grinding, sieving, and packing dry leady materials, in charging and emptying litharge and red lead furnaces, in collecting the red lead, and similar operations in which leady dust is developed, exhaust arrangements shall be provided for preventing the entrance of dust into the workrooms.

7. Apparatus producing leady dust, if their construction and manner of use does not effectually prevent evolution of dust, shall have all cracks protected by thick layers of felt or woollen material, or by similar means, so as to prevent the entrance of dust into the workrooms.

¹ Lead Poisoning in the Smelting and Refining of Lead, U.S. Bur. Lab. Stats., Bull. No. 141, 1914, pp. 88-90.

Apparatus of this character shall be provided with arrangements for preventing compression of air in them. They shall only be opened when the dust in them shall have completely settled and they are absolutely-cool.

Special arrangements in force for the distillation of zinc skimmings.

8. Proposed new furnaces for the distillation of zinc skimmings (for which, according to paragraphs 16 and 25 of the industrial code, a special permission is required) shall be so arranged that (1) there shall be at least a clear space of 10 feet in front of the charging opening; (2) any passages under the distillation rooms shall be roomy, at least 11½ feet high in the center, light and airy.

9. Dust, gases, and fumes arising from the zinc skimmings distillation furnaces shall be collected as near as possible to the point of origin and carried outside the smelting room.

The entrance of gases from the fires into the smelting room shall be prevented as far as possible by suitable arrangements for drawing them off.

10. Sieving and packing of by-products obtained in the distillation of zinc skimmings (poussière, flue dust), shall not be done except in a special room separated from the other work-rooms and complying with the requirements of regulation 1.

Sieving shall only be done in an apparatus so constructed that dust shall not escape.

Employment of workers.

11. Women and young persons shall not be employed or permitted in rooms mentioned in regulation 1, in flue-dust chambers, or dust flues, or in the removal of flue dust.

12. No person shall be newly employed in rooms mentioned in regulation 1, in flue dust-chambers, or dust flues, or in the transport of flue dust, without a certificate of fitness from the surgeon appointed by the higher authorities.

These certificates shall be collected and shown to the factory inspector and appointed surgeon on request.

13. No person shall be employed in charging blast furnaces, apart from mere labouring work on the floors, for more than eight hours daily. The same shall apply in the case of workmen employed in the inside of furnaces when cool, or in emptying flue-dust chambers, or dust flues which contain wet flue dust.

No person shall be employed in cleaning out, from inside, flue-dust chambers, or dust flues containing dry flue dust for more than four hours daily; and including emptying and work of transport of this kind altogether no longer than eight hours daily.

Other workers in rooms specified in regulation 1 shall not work more than 10 hours in 24, exclusive of meal times.

Exception to this is allowed in the case of those workers who are employed for the purpose of a weekly change of shift, and for whom exception as to Sunday employment is permitted by imperial decree.

Clothing, overalls, lavatory accommodations, etc.

14. The occupier shall provide for all persons employed in cleaning out flue dust chambers, dust flues, repairing of cooled furnaces, grinding, sieving, and packing of litharge, red lead, or other colours, complete suits of working clothes, including caps and respirators.

15. Work with lead salts in solution shall not be done except by workers who either grease their hands or are provided with impermeable gloves.

16. The suits of clothes, or overalls, provided in regulations 14 and 15, respirators and gloves, shall be provided in sufficient amount and in proper condition. The occupier shall see that they are always suitable for their purpose, and are not worn except by those workers for whom they are intended; and that they, at stated intervals (the overalls at least once a week, the respirators and gloves prior to use), are cleaned, and during the time that they are not in use are kept in a place specially reserved for each article.

17. A lavatory and cloakroom shall be provided for the use of the workmen in a part of the building free from dust. Separate from it there shall be a dining room. These rooms must be kept free from dust and be warmed during the winter.

In a suitable place provision shall be made for warming the worker's food.

Water, soap and towels, and arrangements for keeping separate the overalls from other clothing taken off before the commencement of work shall be provided in sufficient amount in the lavatory and cloakroom.

The occupier shall afford opportunity for persons engaged in cleaning out flue-dust chambers, dust flues, and the cooled furnaces, to take a bath daily after the end of the work, and for those handling oxides of lead, at least once a week, during working hours, inside the works. The bath-room shall be warmed during the winter.

18. The occupier shall place the supervision of the health of the workers in the hands of a surgeon, appointed by the higher authorities for this purpose, whose name shall be sent to the inspector of factories. The surgeon shall examine the workers at least once a month in the factory, with a view to the detection of symptoms of lead poisoning.

The occupier shall not employ persons suspected by the surgeon of having contracted lead poisoning in the processes mentioned in regulation 1 or in cleaning out flue dust chambers, dust

flues, or furnaces when cold, or transport of the flue dust, until they are quite well. Those who appear peculiarly susceptible shall be permanently suspended from working in these processes.

19. The health register shall be shown to the factory inspector and appointed surgeon on demand. (Similar to regulation 15 of spelter regulations (Appendix i) with an addition.)

20. The occupier shall require the workers to subscribe to the following conditions:

(1) Food must not be taken into the workrooms. Meals may only be taken outside the workrooms.

(2) Workmen must only enter the meal room to take their meals, or leave the factory, after they have taken off their overalls, and carefully washed their faces and hands.

(3) Workmen must use the overalls, respirators and gloves in those workrooms and for the particular processes for which they are given them.

(4) Cigar and cigarette smoking during work is forbidden.

(5) A bath in the factory must be taken every day at the close of their work by those engaged in the emptying and cleaning of flue dust chambers, flues and furnaces when cold, and by those employed on oxides of lead once a week: *Provided*, That this shall not apply in the case of workmen exempted by the appointed surgeon.

Workers contravening these orders will be liable to dismissal without further notice.

21. In every workroom, as well as in the cloakroom and meal room, there shall be posted up by the occupier, in a conspicuous place and in clear characters, a notice of these regulations.

The occupier is responsible for seeing that the requirement of regulation 20 (1) is obeyed. He shall make a manager or foreman responsible for the precise carrying out of regulations 20 (1), 2 and (3). The person thus made responsible shall see to the carrying out of the regulations and for the exercise of necessary care as prescribed in paragraph 151 of The Factory Act.

22. No work in a lead-smelting works shall be commenced until notice of its erection has been sent to the factory inspector. After receipt of the notice he shall personally visit to see whether the arrangements are in accordance with the regulations.

23. These regulations came into force on January 1, 1906.

Where structural alterations are necessary for the carrying out of regulations 1, 5 (1), 6, 9, 10, and 17, the higher authorities may allow an extension of time to a date not later than January 1, 1908.

If it seems necessary on strong grounds of public interest, the council (Bundsrath) may extend the time in particular works until January 1, 1913, and until then allow exceptions from the regulations as regards regulation 13 (1) and (2).

(3) Regulations regarding the Painting Industry¹

(Extract from the "Gewerbeordnung für das Deutsche Reich.") (Translation.)

ORDER of the Imperial Chancellor relating to the processes of Painting, Distempering, Whitewashing, Plastering, or Varnishing. 27th June, 1905. (R.G.B.I., 555.)

I. Regulations for carrying on the industries of painting, distempering, whitewashing, plastering, or varnishing.

Regulation 1.—In the process of crushing, blending, mixing and otherwise preparing white lead, other lead colours, or mixtures thereof with other substances in a dry state, the workers shall not directly handle pigment containing lead, and shall be adequately protected against the dust arising therefrom.

Regulation 2.—The process of grinding white lead with oil or varnish shall not be done by hand, but entirely by mechanical means, and in vessels so constructed that even in the process of charging them with white lead no dust shall escape into places where work is carried on.

This provision shall apply to other lead colours. *Provided* that such lead colours may be ground by hand by male workers over 18 years of age, if not more than one kilogram of red lead and 100 grains of other lead colours are ground by any one worker on one day.

Regulation 3.—The processes of rubbing-down and pumice-stoning dry coats of oil-colour or stopping not clearly free from lead shall not be done except after damping.

All débris produced by rubbing down and pumice-stoning shall be removed before it becomes dry.

Regulation 4.—The employer shall see that every worker who handles lead colours or mixtures thereof is provided with, and wears during working hours, a painter's overall or other complete suit of working clothes.

Regulation 5.—There shall be provided for all workers engaged in processes of painting, distempering, whitewashing, plastering, or varnishing, in which lead colours are used, washing utensils, nail brushes, soap and towels. If such processes are carried out in a new building or in a workshop, provision shall be made for the workers to wash in a place protected from frost, and to store their clothing in a clean place.

Regulation 6.—The employer shall inform workers, who handle lead colours or mixtures thereof, of the danger to health to which they are exposed, and shall hand them, at the commencement of employment a copy of the accompanying leaflet (see appendix, next page), if they are not already provided with it, and also a copy of these Regulations.

¹ Reports of the Departmental Committees appointed to investigate the danger attendant on the use of lead, etc., Vol. III, p. 8.—H.M. Stationery Office, 1920.

II. Regulations for the processes of painting, distempering, whitewashing, plastering, or varnishing when carried on in connection with another industry.

Regulation 7.—The provisions of paragraph 6 shall apply to the employment of workers connected with another industry, who are constantly or principally employed in the processes of painting, distempering, white-washing, plastering, or varnishing, and who use, otherwise than occasionally, lead colours or mixtures thereof. The provisions of paragraphs 8—11 shall also apply if such employment is carried on in a factory or shipbuilding yard.

Regulation 8.—Special accommodation for washing and for dressing shall be provided for the workers, which accommodation shall be kept clean, heated in cold weather, and furnished with conveniences for the storage of clothing.

Regulation 9.—The employer shall issue regulations which shall be binding on the workers, and shall contain the following provisions for such workers as handle lead colour and mixtures thereof:

1. Workers shall not consume spirits in any place where work is carried on.
2. Workers shall not partake of food or drink, or leave the place of employment until they have put off their working clothes and carefully washed their hands.
3. Workers, when engaged in processes specified by the employer, shall wear working clothes.
4. Smoking cigars and cigarettes is prohibited during work.

Furthermore, it shall be set forth in the regulations that workers who, in spite of reiterated warning, contravene the foregoing provisions, may be dismissed before the expiration of their contract without notice. If a code of regulations has been issued for the industry (par. 134a of the G.O.), the above indicated provisions shall be incorporated in the said code.

Regulation 10.—The employer shall entrust the supervision of the workers' health to a duly qualified medical man approved by the public authority, and notified to the factory inspector (par. 139b of the G.O.), and the said medical man shall examine the workers once at least in every six months for symptoms indicative of plumbism.

The employer shall not permit any worker who is suffering from plumbism or who, in the opinion of the doctor, is suspected of plumbism, to be employed in any work in which he has to handle lead colours or mixtures thereof, until he has completely recovered.

Regulation 11.—The employer shall keep or shall cause to be kept a register in which shall be recorded the state of health of the workers, and also the constitution of and changes in the staff; and he shall be responsible for the entries being complete and accurate, except in so far as they are effected by the medical man.

This register shall contain:

1. The name of the person keeping the register.
2. The name of the medical man entrusted with the supervision of the workers' health.
3. The Christian name, surname, age, place of residence, the date of commencement and of termination of employment of each worker employed in any process named in paragraph 1, and also the nature of his employment.
4. Date and nature of the illness of a worker.
5. Date of recovery.
6. Dates and results of the medical man's general examinations prescribed by paragraph 10.

The register shall be produced when required by the Inspector of Factories (paragraph 139b of the G.O.), or by the medical inspector.

Regulation 12.—The foregoing regulation shall come into force on 1st January, 1906.

Appendix¹

Memorandum on lead poisoning.

How is it possible for painters, distemperers, white washers, plasterers, varnishers, etc., to protect themselves against lead poisoning?

All lead paints, such as white lead, lead chromate, massicot, litharge, minium, lead dioxide, Pattison white lead, Cassel yellow, English yellow, Naples yellow, lead iodide, are poisons.

Painters, distemperers, white washers, plasterers and varnishers, etc., who come in contact with lead paints, are exposed to the danger of lead poisoning.

Lead poisoning is caused when lead colours enter the body, even if in small quantity. These colours adhere to one's hands, beard and clothes and thus are easily introduced into one's mouth in eating, drinking, smoking, and chewing; or they are inhaled in the form of dust.

The results are not noticed immediately. They appear only after weeks, months and even years, that is, not until there are large enough quantities of lead in the body to bring about the disease.

What are the symptoms of lead poisoning?

The first symptoms of lead poisoning are a blue-gray edge on the gums, called the lead line, and anæmia which shows itself by a pallor of the face and lips. The further symptoms are mani-

fold. In most cases lead-colic occurs. The sufferer feels violent, convulsive stomach ache (colic) in the umbilical region; the abdomen is retracted and hard; he vomits and suffers from constipation, occasionally diarrhoea. In other cases paralysis occurs; it usually affects those muscles which are used in stretching one's fingers and appears in most cases in the arms; in exceptional cases other muscles are affected, those in the arms and legs or in the larynx. Now and then lead poisoning causes violent pains in the joints. Mostly the knees are affected and less often the joints of the arms. In very serious cases the brain is affected (violent headache, convulsions, loss of consciousness, or great restlessness, loss of sight). And finally lead poisoning has a causal relation with kidney disease known as "shrivelling kidney", and with gout. In the case of women, miscarriages and still-births often result from lead poisoning. And children who are born alive are subject to a higher mortality in the first year. Lead poisoning may also be transmitted to children through the mother's milk.

Aside from the serious cases of lead poisoning which in one way or another affect the brain and which not seldom result in death, the disease is most likely to be cured if the patient can be removed from further injurious effects of lead. The cure is effected only after several weeks, or, in serious cases, even several months.

Prevention of lead poisoning.

The popular idea that the regular use of certain medicines, such as potassium iodide, Glauber's salt (sodium sulphate), etc., or the drinking of milk is a sufficient means of prevention does not hold true. A certain value, however, may be attached to a nourishing diet, especially one rich in fats, and in this respect to the drinking of milk also. Cleanliness and moderation are the most effective means of prevention. Persons who are in the habit of consuming fair quantities of alcoholic drinks, without exactly belonging to the class of heavy drinkers, are much more subject to lead poisoning than abstainers. Whiskey should not be consumed, especially during working hours.

Persons who come in contact with paints and colours containing lead should be scrupulously cleanly. They should above all observe the following rules:

1. Hands and working clothes should be soiled as little as possible. It is advisable to keep one's nails as short as possible.
2. Since one's hands cannot be kept perfectly clean, one should abstain from using tobacco in any form during work hours.
3. Working men should not take food or drink, nor should they leave their place of work, before they have changed clothes and carefully washed their hands with soap, preferably with pumice stone or marble soap. Whenever during the work the face, and particularly the beard, have been soiled, they should be thoroughly washed. If it is necessary to take a drink of water occasionally during the work, the edges of the glass must not be touched with one's hands.
4. The working clothes prescribed by the employer for certain types of work should be invariably used.

In order to prevent the inhalation of dust containing lead, the rules and regulations governing this matter must be rigidly followed; especially the grinding of white lead in oil and varnish must not be done by hand but in dust proof containers; furthermore, coats of paint must not be pumice-stoned or sandpapered in a dry condition.

If in spite of all precautions a working man who comes in contact with lead paints should fall ill and show symptoms of lead poisoning, he should, in his own interest and in that of his family, at once consult a physician, stating that he has been working with lead paints.

Berlin, June 27th, 1905.

*The Deputy of the Imperial Chancellor,
COUNT VON POSADOWSKY.*

(4) Notification relating to the establishment and management of works where the manufacture of electric accumulators from lead or lead compounds is carried on.¹

(May 6, 1908)

In pursuance of Section 120e of the Industrial Code, the Federal Council has issued the following regulations respecting the establishment and management of works where the manufacture of electric accumulators from lead compounds is carried on.

1. In works where the manufacture of electric accumulators from lead or lead compounds is carried on, all workrooms where lead or lead compounds are prepared or manipulated shall be at least 3 meters high, and shall be provided with windows which can be opened and which afford effective ventilation.

The rooms where the plates are formed shall be provided with effective arrangements for ventilation.

2. In rooms where lead dust is created or where lead or lead compounds become dispersed, the floor shall be so constructed so as to be impermeable to water. The walls and ceilings of such rooms shall be limewashed at least once a year, unless they are covered with a smooth, washable facing, or with oil painting.

¹ Gilbert Stone, *Laws and Regulations relating to Lead Poisoning*, 1922, pp. 151-154.

Wood, soft asphalt, or linoleum shall not be used as floor covering in such rooms, nor shall the walls thereof be covered with paper.

3. Every melting pot for lead shall be provided with a conical hood, placed above it, and having a good draught into the open air or up a chimney.

4. In rooms where the lead plates (grids or frames) are machined by means of band saws, circular saws, planing machines, etc., suitable apparatus must, as far as possible, be provided to draw off and collect scattered particles of lead and lead dust at the actual spot where they are produced.

5. Apparatus for the production of metallic lead dust shall be so constructed and kept tight as to prevent the escape of the dust, both during the manufacturing process and when the apparatus is being emptied.

6. The sifting, mixing, and dumping of the material used for filling the plates, if it contains lead or lead compounds, the removal of paper or other coverings from the dried plates, and any similar processes in the manipulation of the dry or dried filling material (paste) in the course whereof dust is generated, shall only be carried on where there are suitable arrangements for drawing off the dust, or in apparatus so constructed as to prevent the escape of such dust.

7. Open vessels containing lead or lead compounds shall be placed on a grating, over a stand surrounded by a rim, so arranged that when the lead dust or lead compounds are taken out of the vessel any scattered substance shall be caught into the stand.

8. The following operations must be carried on each in a special room separated from all other workrooms:

- (a) The preparation of lead plates, grids, or frames by means of a mechanical process (regulation 4);
- (b) The production of lead dust (regulation 5);
- (c) The manufacture and mixing of the material used for filling the plates in so far as such operations are carried on by mechanical means.

9. The surface of the benches whereon the said substance is pasted on or pressed into the plates (grids or frames) must be smooth and grooveless; such benches must be washed once daily.

10. Lead burning affected by means of hydrogen, water-gas, or coal gas blowpipes shall, so far as the nature of the works permits, only be carried on in special workshops provided with effective arrangements for drawing off such fumes.

This provision shall not apply to the soldering of connections between cells such as cannot be carried on outside the forming (charging) rooms.

11. Lead used in the production of inflammable gas and sulphuric acid used in lead processes must be kept technically pure.

12. The workrooms must be kept as free as possible from pollution of lead or lead compounds. The floor of the workrooms specified in regulation 2 must be washed once at least every day, and every day after work hours.

13. The employer shall provide a sufficient supply of suitable working clothes and caps for the use of the workmen employed in the manufacture of accumulators. He shall, by making suitable regulations for the purpose and by careful supervision, ensure that such working clothes shall be used only by the persons to whom they are allotted, and he shall see that they are washed at least once a week and kept, when not in use, in the places provided for the purpose.

14. A lavatory and cloak-room, and a separate mess-room shall be provided for workmen in a part of the premises which is free from dust. Such rooms shall be kept in a cleanly state and free from dust, and shall be heated during the cold season.

A sufficient supply of water and vessels for rinsing the mouth and of suitable nail-brushes, soap and towels for washing the hands, together with sufficient accommodation for keeping garments not worn during work, shall be provided in the said lavatory and cloak-room.

The employer shall give every workman an opportunity of taking a warm bath at least once a week.

15. No woman or young person shall be employed in occupations involving contact with lead or lead compounds.

16. No person shall be engaged for work in the manufacture of accumulators unless he produces a certificate of a medical practitioner appointed by the higher administrative authority for the purpose, certifying that he is in a suitable state of health for such employment. The said certificate shall be collected and preserved, and must be produced on demand of the inspector. (Section 139b of the Industrial Code.)

17. The employment of workmen engaged in mixing and manufacturing the material used for filling accumulators and applying it to the plates (grids or frames) shall be so regulated that the period of employment, either

- (a) shall not exceed eight hours daily, with a break of at least one hour and a half, or
- (b) shall not exceed six hours daily without a break for meals.

If the period of employment is regulated in the manner prescribed above under (b), the said workmen may be employed on the same day in other work, provided such employment does not bring them into contact with lead or lead compounds, and a break of at least two hours is allowed between the two kinds of employment.

Every employer shall, within one week of the opening of his establishment, give notice to the local police authority of the periods of employment adopted, and may only adopt a different system after having first given notice of his purpose.

The employer shall appoint a qualified medical practitioner, whose name shall be notified to the inspector, to keep watch over the health of his workmen. The said practitioner shall examine the workmen at least once every month for symptoms of lead poisoning.

On the order of the medical practitioner, workmen showing symptoms of disease consequent on absorption of lead shall be removed from their employment either until they are completely cured, or permanently, if they prove to be especially susceptible to the effects of lead.

19. It shall be the duty of the employer to keep account of the transference or retention of the workmen engaged in such processes, and the state of their health in a register kept for the purpose, or to cause such register to be kept by an official of the firm. He shall be responsible for all entries made in the said register other than those made by the medical practitioner.

The register shall contain the following particulars:

- (1) The forename and surname of each workman, his age and residence, the date when he enters and leaves the employment, and the nature of his employment.
- (2) The name of the person who makes the entries.
- (3) The name of the medical practitioner appointed to keep watch over the health of the workmen.
- (4) The date when any workman falls ill and the nature of his illness.
- (5) The date of his recovery.
- (6) The dates and results of the general medical examination prescribed in regulation 18.

20. The employer shall issue regulations on the following matters which shall be binding on workmen employed in the manufacture of accumulators:

- (1) No workman shall take any food with him into a workroom or bring or drink on the premises any spirituous liquor. No meals shall be taken in the workrooms.
- (2) The workmen must wear the clothes provided for them.
- (3) No workman shall enter the mess-room, take a meal, or leave the premises until he shall have first removed his working clothes and carefully washed his hands and face and rinsed his mouth.
- (4) No workman shall smoke, take snuff, or chew tobacco during work.

It shall be provided in the said regulations that any workman who, despite repeated warnings, shall continue to contravene the same, may be dismissed before the expiration of the contracted term, and without notice.

21. A written or printed copy of regulations 1-21 of these regulations and of the regulations issued by the employer in pursuance of regulation 20, shall be affixed in a conspicuous place in every workroom and also in the cloakroom and mess-room.

22. In case of any contravention of regulations 1-21 of these regulations, the police authority may order the cessation of work in any departments affected, until such time as the prescribed conditions have been established. (Section 147, paragraph 4, of the Industrial Code.)

23. These regulations shall come into operation on July 1st, 1908, in the place of the regulations issued in the Notification of the Imperial Chancellor of 11th May, 1898. (R.G. Bl., p. 176).

(5) Regulations relating to the installation and working of zinc smelting works and zinc-ore roasting works¹

(December 13, 1912)

In pursuance of section 120e of the Industrial Code, the Federal Council has issued the following regulations respecting the installation and working of zinc-smelting works and zinc-ore roasting works:

1. The rooms in which zinc ore is crushed, calcined, or roasted or in which metallic zinc is obtained by distillation must be roomy, lofty, and so arranged as to be adequately and continually ventilated.

They must be provided with a level and firm floor so that the dust can be easily removed by suction or by a wet process.

In order to avoid accumulations of dust, the walls must have a smooth surface. If they are not covered with a washable coating or painted in oil, they must be newly lime-washed at least once a year.

The roof beams and covers of the distilling furnaces must be thoroughly cleansed of dust at least once a year by suction or by some other suitable method.

2. In the rooms designated in regulation 1 there must be a sufficient supply of good drinking water, protected from the penetration of dust, near the work places and always available for the workers, in such a way that they can procure it conveniently at any time without going out into the open air.

¹ Gilbert Stone, *Laws and Regulations relating to Lead Poisoning*, 1922, pp. 163-166.

There must be arrangements for sprinkling the floor near the furnaces and in the trenches. The floors of rooms designated in regulation 1 must be cleaned at least once a day by suction or by the wet process.

3. The crushing of zinc ore shall only be carried on in apparatus so constructed that the escape of dust is effectively prevented.

4. The roasting and calcining furnaces shall be provided with efficient exhaust apparatus for the purpose of drawing off the escaping gases. Care shall be taken to see that the effective action of the exhaust apparatus is not interrupted while the furnaces are in use.

5. In order to avoid the generation of dust, ores intended for charging the distilling furnaces shall only be stored in front of the furnace, mixed with other materials, and put into the furnace, in a damp condition.

6. Dust, gases, and fumes given off from the distilling furnaces shall be collected by efficient arrangements as near as possible to the point of escape, and drawn off from the smelting room.

Suitable arrangements must also be made to draw off the furnace gases, and prevent them, as far as possible, from penetrating to the smelting room.

7. The waste ashes (Räumasche) must be drawn off in the smelting room; they must be collected in closed conduits or receptacles under the furnace, and transferred direct from these into trucks below the distilling rooms.

The higher administrative authority may allow exceptions to this rule, subject to revocation and not extending beyond 31st December, 1922, in so far as arrangements of the kind indicated in paragraph 1 can only be adopted with structural changes involving a disproportionate expense.

8. Sifting and packing the by-products obtained in the course of zinc distillation (zinc dust and zinc fumes) shall only be carried on in a special room, separated from the other work rooms and satisfying the requirements of regulation 1.

Sifting shall only be carried on in apparatus so arranged that the escape of dust is effectively prevented.

9. Women and young persons shall not be employed:

- (1) In charging the zinc-smelting furnaces;
- (2) In emptying the carboys and receivers;
- (3) In emptying the conduits and fume chambers connected with distilling, calcining and roasting furnaces;
- (4) In sifting and packing and in conveying the by-products obtained in the process of zinc distillation;
- (5) In sifting dry waste ashes and dry ashes out of the furnaces;
- (6) In loading and removing residues and ashes out of the furnaces;
- (7) In other processes necessitating their admission to the distilling rooms and particularly in bringing the materials for charging the furnaces.

The rule contained under (7) shall not apply to the employment of male young persons in masonry work, in building new furnaces, or repairing cold furnaces. Notwithstanding, they shall only be employed in rooms in which no distilling furnaces are in use.

10. Workers between 16 and 18 years of age shall not be employed in loading and removing waste ashes, or the ashes out of the furnaces, or in sifting and packing the by-products obtained in the process of zinc distillation.

They may only be employed in other processes connected with distilling operations should the certificates issued by a qualified medical man, authorized for the purpose by the higher administrative authority, show that no objections can be raised to such employment on account of their health or physical development. The certificates shall be collected and preserved and presented to the industrial inspectors and to the medical officers on demand.

11. A lavatory, bath-room, and cloak-room must be provided for the workers in a part of the premises which is free from dust, and also a separate mess-room. These rooms must be as near as possible to the work places. They must be kept clean and free from dust and heated in the cold season.

In the cloak-rooms, sufficient arrangements for keeping working and outdoor clothes must be provided, so constructed that there is no risk of the outdoor clothes becoming soiled; a sufficient supply of water, soap, and towels shall be placed at the disposal of the workers without charge.

The workers must be given the opportunity of taking a warm bath at least twice a week. Opportunity for so doing shall be given during working hours, unless, in the opinion of the industrial inspector, this appears impracticable for important considerations relating to the work.

12. The examination and supervision of the state of health of the workers shall be entrusted to a qualified medical man authorized for the purpose by the higher administrative authority, and notified to the industrial inspector; the said medical man shall examine every workman before engagement. Only those workers shall be engaged in respect of whom he declares that

the work is not open to objection. In addition, the medical man shall visit the workers at least once a month at the works, observe any symptoms of illness in them, and particularly any signs of lead poisoning, and thoroughly examine those cases which seem to him suspicious. By order of the medical man, any workmen who show symptoms of illness resulting from the occupation, especially signs of lead poisoning, shall be excluded from the operations named in regulation 9, paragraph 1, until they have completely recovered, and workmen who prove especially susceptible to the effects of the occupation shall be permanently excluded therefrom.

13. The employer shall keep a register recording the changes in, and present position as regards the workers and the state of their health, or he shall cause the same to be kept by a works official. The employer shall be responsible for the completeness and correctness of the entries, except in so far as they are made by the medical man.

This register must contain:

- (1) The name of the person who keeps the register;
- (2) The name of the medical man entrusted with the supervision of the health of the workers;
- (3) The name in full, age, and residence of each worker, the dates when he enters and leaves the employment, and the nature of his employment;
- (4) The result of the original examination;
- (5) The date and nature of the illness of any worker, together with a statement whether in the opinion of the medical man, the illness is traceable to lead or not;
- (6) The date of his recovery;
- (7) The dates and results of the inspections and examinations prescribed in regulation 12.

With the approval of the higher administrative authority, cards may be used instead of a book, if they contain all the necessary statements and their completeness is guaranteed.

The book or collection of cards must be submitted to the industrial inspector and the medical inspector at any time on demand.

The workers shall not take any articles of food into the workrooms. They shall only be permitted to take meals outside the workrooms. The workers shall not enter the mess-room, take their meals, or leave the premises before they have carefully washed their hands and faces.

The employer shall see that these rules are observed.

15. New distillation furnaces to be constructed, for which a special sanction is required in pursuance of Sections 16 *et seq.* and 25 of the Industrial Code, must be so arranged that

- (1) there is a free space of at least six metres in front of the opening for charging, or in the case of furnaces, the openings of which are opposite each other, at least 10 metres between them;
- (2) the ways (trenches) between the distillation rooms must be roomy, at least 3.5 metres high at the vertex, light and airy.

16. In the event of mechanical changes in zinc smelting works, making it impossible to completely carry out the provisions of regulations 1-8 and 15, the higher administrative authority may allow exceptions, subject to revocation, if it can be proved that the workers are protected against dangers to life and health in some other way, at least to as great an extent as is provided in the said provisions.

17. The power of the competent authorities to issue, by means of instructions, further requirements for the protection of the life and health of the workers in particular premises, in pursuance of regulations 120*d* and 120*f* of the Industrial Code, shall not be affected by the preceding provisions.

18. In every workroom, and also in the cloak-rooms and mess-room a written or printed copy of this notification shall be affixed in a conspicuous place.

19. The preceding provisions shall come into force on 1st January, 1913, in place of the Notifications of 6th February, 1900 (R.G. Bl., p. 32) and of 25th November, 1910 (R.G. Bl., p. 1105).

The higher administrative authority may grant exemptions, subject to revocation, for women employed before the 1st January, 1913, in the operations designated in regulation 9, paragraph 1 (2, 3, 15, or 7), to continue to be so employed in these processes, until 1st January, 1920, provided that this employment only takes place before the beginning or after the conclusion of the so-called operations (Manöver) at the furnaces.

Until 1st January, 1920, the higher administrative authority may allow exceptions, subject to revocation, to the limitation prescribed in regulation 9, paragraph 2, sentence 2.

Exceptions granted in pursuance of earlier provisions shall cease to apply on 31st December, 1913.

(6) Lead compounds: order and notification¹**(January 27, 1920)**

4. Verordnung über die Einrichtung und den Betrieb von Anlagen zur Herstellung von Bleifarben und anderen Bleiverbindungen. Vom 27. * January, 1920. (Reichsgesetzblatt Nr. 18, S. 109.)

Order respecting the installation and working of establishments for the manufacture of lead colours and other lead compounds. Dated 27th January, 1920.

In pursuance of Section 120e of the Industrial Code, the Federal Minister of Labour issues the following regulations, approved by the Federal Council, respecting the installation and working of establishments for the manufacture of lead colours and other lead compounds.

1. The following regulations shall apply to all establishments where the manufacture of lead colours or other lead compounds (white lead, chromate of lead, lead sulphate, massicot, litharge, red lead, peroxide of lead, English yellow, Neapolitan yellow, acetate of lead, etc.), or mixtures thereof with other substances, is carried on as either a principal or a subsidiary industry.

The regulations shall not apply to:

- (a) lead smelting works, even if the manufacture of the substances specified in paragraph 1 is carried on there;
- (b) works in which only colours containing lead which have already been ground with oil or varnish are mixed with each other or with other substances not containing lead, subjected to further processes of manufacture, or packed;
- (c) the manufacture of colours, substances or mixtures which contain less than 1 per cent. of lead or which contain lead only in the form of sulphide of lead (galena).

Painting, decorating, plastering, coopering and varnishing works, and works in which painting, decorating, plastering, coopering and varnishing are carried on in connection with other industries, shall continue to be regulated in accordance with the provisions of the Notification of the Federal Chancellor, dated 27th June, 1905 (Reichsgesetzblatt, p. 555).

If the substances specified in paragraph 1 are manufactured, mixed or packed in special departments entirely separate from the rest of the works, the regulations shall apply only to the said departments and to the persons permanently or temporarily employed therein.

2. Rooms in which the substances specified in Section 1, paragraph 1, are manufactured, manipulated or packed, shall be spacious, high, and so constructed as to be adequately and continuously ventilated.

They shall be provided with level, firm and impervious floors, so that dust can easily be removed by a damp process or by suction. The floor shall be thoroughly cleaned by a damp process or by suction as often as necessary, but in any case at least once a day. Any rails or sunk tracks therein shall be thoroughly cleaned every day after work is over. In each of the rooms specified in paragraph 1, there shall be installed either an apparatus for removing dust by suction or a water tap with hose attachment. Movable suction apparatus may be used. The dust collected by suction shall be disposed of so as to create no nuisance and so that it cannot be introduced into the workrooms or inhaled by the workers.

Walls shall have a smooth and impervious surface, and shall be lime-washed at least twice a year, or, if they are covered with a washable facing (glazed tiles or bricks, etc.) or with oil paint, shall be washed at least twice a year. Furnaces, apparatus, pipes, transmission gear, stair rails, etc., shall be kept free from dust and other dirt, and shall be thoroughly cleaned in a suitable manner whenever necessary, but in any case not less than once a fortnight.

Handles and helms of shovels, spades, stirring poles and other tools shall be thoroughly cleaned every day after work is over.

3. The entrance of dust, gases and fumes containing lead into the workrooms shall be effectively prevented by means of suitable apparatus. Apparatus used in the manufacture of red lead, white lead, lead sulphate or other lead compounds by evaporation, pulverization, or the heating of lead compounds shall be provided with mechanical exhaust ventilation maintaining continuously within the apparatus a pressure below that of the atmosphere. Workrooms which it is not possible to protect completely against the entrance of dust, gases and fumes containing lead, shall be separated from other workrooms in such a way that dust, gases or fumes shall not enter the latter.

In new establishments, or in the case of a substantial alteration of an existing establishment, the rooms in which dry substances containing lead are crushed, ground, sifted and packed, shall in all cases be separated from other workrooms by impervious walls.

In new establishments or in the case of a substantial alteration of an existing establishment, red lead furnaces shall be filled and emptied mechanically. Red lead furnaces without mechanical appliances for filling and emptying shall not be used after 1st January, 1925, even in old works in which no alteration has taken place.

4. Melting pots for lead shall be covered with exhaust apparatus (hoods) with a good draught, fitting tightly and provided with openings for handling. The exhaust pipe shall discharge into the open air or into a chimney. The lead ashes deposited during the process of melting lead shall not be thrown onto the floor, but shall be collected in a special impervious receptacle.

5. The inner surface of oxidation chambers shall, wherever possible, be constructed of smooth, impervious materials. A water tap with a hose attachment shall be installed in front of each oxidation chamber.

The chambers shall be thoroughly damped after the completion of the oxidation process by the introduction of steam for not less than 24 hours. They shall be thoroughly cooled and ventilated before being entered, but in such a way as not to dry the chamber, the frames, or the white lead. Wherever possible, the white lead shall be washed from the laths or bars by means of a powerful stream of water. The white lead deposited on walls, staging, laths or bars shall be as completely as possible removed therefrom. The oxidation chambers shall be adequately lighted so long as work is going on therein.

Supplies of crude white lead shall be kept damp during transference to the grinding room and as long as they remain therein.

The walls of the oxidation chambers and the staging, laths and bars therein, shall be thoroughly damped before the chamber is filled.

The employer shall appoint a foreman or charge hand, thoroughly acquainted with these regulations and other precautionary measures to supervise throughout its duration the work in connection with the emptying of the oxidation chambers. The person appointed to exercise supervision shall be responsible under Section 151 of the Industrial Code for the observation of the regulations and for the adoption of the necessary precautions.

6. In the preparation and manipulation of wet colours or substances containing lead, viz.: in grinding and wet grinding, hand work shall be replaced by the use of mechanical appliances as far as is necessary to reduce to a minimum the soiling of the workers' hands and clothes and the floor.

The settling vats or vessels shall not be entered for the purposes of emptying if they can be emptied mechanically or from the outside.

7. The inner surface of the drying chambers which are entered for the purposes of filling or emptying shall be as smooth and impervious as possible: the floor shall be level, firm and impervious, so that it can be easily cleaned by suction or by washing. The walls, floors, and frames in the drying chambers shall always be kept clean.

New drying chambers for white lead shall be so constructed that it is not necessary to enter them.

8. In grinding, sifting and packing of dry colours or substances containing lead, the filling and emptying of litharge, and red lead stoves, red lead containers, and all other apparatus in connection with which dust containing lead is given off, the entrance of dust into the work-rooms shall be effectively prevented by means of mechanical exhaust ventilation or other suitable means. The grinding and sifting of dry substances containing lead shall be carried on only in a tightly closed apparatus connected with mechanical exhaust ventilation continually maintaining within the apparatus a pressure less than that of the atmosphere.

The packing of litharge, red led and dry white lead in packages of 60 kilogrammes and upwards shall be done only by means of mechanical appliances provided with efficient exhaust ventilation.

9. White lead shall not be ground in a dry state with oil or varnish, but only in a wet condition (known as paste). Even the use of dry white lead damped afresh with water shall not be permitted in this connection.

10. Women shall not be employed in the establishments specified in Section 1, paragraph 1, except in the cleaning of rest rooms, mess rooms, cloakrooms, lavatories and bathrooms, and in washing and repairing working clothes. They shall not enter rooms in which substances containing lead are manufactured, mixed, packed, stored, or handled.

Persons under 18 years of age shall not be employed or remain in establishments in which lead colours or other lead compounds are the sole or the principal product. In other establishments they shall not be employed or remain in rooms in which they are liable to come in contact with substances, dust, gases, or fumes containing lead.

Paragraphs 1 and 2 shall apply in the case specified in Section 1, paragraph 4, only to the departments in which the substances containing lead are manufactured, mixed or packed.

11. The employer shall give instructions beforehand to workers who come into contact with substances containing lead, as to the deleterious effects of lead upon health and the precautions necessary in connection therewith, and shall supply them with copies of the Notice issued by the Federal Ministry of Labour.

12. Oxidation chambers shall not be filled or emptied between the hours of 9 p.m. and 5 a.m.

Workers who fill or empty oxidation chambers shall not be employed for more than six hours daily. They shall be allowed a break of at least one hour after each two hours' work.

Workers shall not be employed for more than six hours on any day on which they are engaged in packing dry substances of the nature specified in Section 1, paragraph 1, or closing casks filled with the said substances, even if they have been engaged in other work during part of the time. They shall be allowed a break of not less than two hours during working hours. This provision shall not apply if the workers are not employed for more than two hours during one shift in packing substances and colours containing lead, or if they are employed in connection with packing machines which are provided with efficient exhaust ventilation.

Workers shall not remain in the workrooms during breaks.

13. The employer shall provide a complete working suit and a cap for each worker who comes into contact with lead or substances containing lead, and suitable footgear for those who are employed in rooms with damp floors, or in the emptying of oxidation chambers, settling vats, or crystallization vats.

14. The employer shall not allow workers to perform preliminary work and cleaning in connection with which the dust cannot be removed immediately and completely by suction unless their nose and mouth are covered with a respirator, muslin bandage, damp sponge or other efficient means of protection.

15. The employer shall supply each worker with the working clothes, respirators, etc., specified in Sections 13 and 14, in sufficient number and suitable quality. He shall see that these articles are used for the purpose for which they are provided and only by those workers to whom they are assigned, and that working clothes are washed and repaired at least once a week at his expense and respirators, etc., cleaned before each occasion on which they are used, and each article kept in its proper place when not in use.

Working clothes shall be washed before they are repaired. The washing shall be done at the works itself.

16. Workers shall not change their clothes in the workrooms, and no articles of clothing of any kind shall be kept therein.

A lavatory and cloakroom and a separate meal room shall be provided for the workers. The said rooms shall be kept clean and free from dust and shall be heated in the cold season. Appliances for warming food shall be provided in the messroom or in some other suitable place.

At least one washing convenience for every two workers shall be maintained in the lavatory and cloakroom. Hot and cold water shall be supplied in sufficient quantity. Each worker shall be supplied with a nail brush, a vessel for rinsing his mouth, a sufficient quantity of soap, and a clean towel once a week, free of charge.

At least one clothes cupboard with two divisions shall be provided for each worker to deposit the clothes which he takes off.

In establishments in which white lead, red lead, litharge or lead sulphate are manufactured, two clothes cupboards which can be locked shall be provided for each worker, one of which shall be used for keeping outdoor clothes and the other for keeping working clothes when not in use. Cupboards for working clothes and for outdoor clothes shall be separate, and so arranged that the workers must pass through the lavatory after taking off their working clothes in order to reach the cupboard containing their outdoor clothes.

The employer shall install a bathroom for workers in a suitable part of the works, properly fitted up, kept clean, and heated in the cold season. At least one douche-spray or bath shall be provided for every five workers on the day shift. The higher administrative authority, after consultation with the workers' committee,¹ may authorize exceptions to the provisions of this paragraph if the workers are otherwise ensured opportunities of taking baths, except in the case of works in which white lead, lead sulphate, red lead or litharge is manufactured.

Hot and cold water shall be supplied in sufficient quantity during the whole of the time when baths are being taken.

The employer, in agreement with the workers' committee, shall issue rules respecting baths, requiring workers employed in emptying oxidation chambers, white lead and lead peroxide settling vats, and acetate of lead crystallization vats, to take a bath daily, and all other workers to do so at least twice a week.

Each worker shall be supplied for bathing purposes with a clean towel at least once a week, and a sufficient quantity of soap, free of charge.

17. The examination and supervision of the state of health of the workers shall be entrusted to a qualified medical practitioner authorized for the purpose by the higher administrative authority, and notified to the industrial inspector. The authorization shall not be issued until the medical practitioner has given an undertaking to observe the service instructions issued by the Federal Ministry of Labour. The medical practitioner shall examine every worker before engagement, and at the same time shall inform him of the danger of lead poisoning. Only those workers shall be engaged in respect of whom the medical practitioner declares that there is no predisposition to lead poisoning. The medical practitioner shall inspect every worker employed at least twice a month in establishments in which white lead, lead sulphate, litharge or red lead is manufactured, and at least once a quarter in all other establishments, shall observe any symptoms of illness in them, and particularly signs of lead poisoning, and shall examine thoroughly those cases which seem to him suspicious.

By order of the medical practitioner, any workers who show symptoms of illness resulting from their occupation, especially signs of lead poisoning, shall be excluded from operations in the course of which they come into contact with lead or substances containing lead, until they have completely recovered, and workers who prove specially susceptible to the effects of their occupation shall be permanently excluded therefrom.

If the employer proposes to dismiss a medical practitioner entrusted with the supervision of the state of health of the workers, he shall notify the higher administrative authority of his intention, giving his reasons.

¹ Established under the Order of 23rd December, 1918, respecting collective agreements, etc., of which the original text is given in the "Bulletin des Internationalen Arbeitsämter," volume 17, page 182. Now replaced by the Works Council or Council of Wage-Earning Employees—See Works Councils Act, section 104 (i) and (viii). ("Legislative Series of the International Labour Office," 1920, Ger. 1-2.)

18. It shall be the duty of the employer to keep a special register in book form of the transference or retention of workers, and their state of health, or to cause the same to be kept by an official of the works. He shall be responsible for the completeness and accuracy of all entries, other than those made by the medical practitioner.

The said register shall contain:

- (1) The name of the person who keeps the register;
- (2) The name of the medical practitioner entrusted with the supervision of the health of the workers under Section 17;
- (3) The name in full, age, residence, date of engagement and dismissal of each worker, and the nature of his employment;
- (4) The result of the original examination;
- (5) The date and nature of each illness of any worker, with a statement whether, in the opinion of the medical practitioner (Section 17) the illness is connected with lead or not;
- (6) The date of his recovery;
- (7) The dates and results of the inspections and examinations prescribed in Section 17.

Cards may be used instead of a book, subject to the approval of the higher administrative authority, if they contain all the requisite information and their completeness is guaranteed. The book or collection of cards shall be submitted to the industrial inspector and the medical inspector at any time on demand.

19. No worker shall bring brandy, beer, or any other spirituous liquor to the premises.

No worker shall bring food into the workrooms. Meals shall be taken either in the meal room (Section 16) or outside the works.

No worker shall enter the meal room, take a meal or leave the works until he has first removed his working clothes, freed his hair from dust, carefully washed his hands and face, and rinsed out his mouth.

Workers must use the working clothes, respirators, etc., in all circumstances in which they are required to do so.

Workers shall not smoke, take snuff, or chew tobacco during work.

20. The employer, in co-operation with the workers' committee,* shall see that the provisions of Sections 6, 10, 12 (last paragraph), 16 and 19, respecting the behaviour of the workers on the works premises, are observed.

Workers who in spite of repeated warnings contravene the regulations, may be dismissed before the expiration of the contracted term and without notice.

21. The higher administrative authority, after consultation with the workers' committee* and the industrial inspector concerned, may authorize exceptions (subject to revocation) in special cases, on request:

- (a) To the provisions of Section 8, paragraph 2, for works in which white lead, litharge or red lead is manufactured in small quantities;
- (b) To the provisions of Section 2, paragraph 2, sentence 4; and section 8, paragraph 1, sentence 2, for works in which other lead colours are manufactured;
- (c) To the provisions of Section 2, paragraph 2, sentence 4; Section 8, paragraph 1, sentence 2, and paragraph 2; Section 9, and Section 12, paragraph 3, for works in which lead colours are not manufactured, but only ground, mixed with other substances, or packed;

provided that care is taken that the workers are protected by means of suitable appliances against contact with substances or dust containing lead.

22. In any case in which technical improvements in the manufacture of lead colours or lead compounds render it impossible or unnecessary to carry out in their entirety the provisions of sections 1 to 8, the higher administrative authority, after consulting the workers' committee* and the industrial inspector concerned, may authorize exceptions (subject to revocation), provided that the workers are ensured in some other manner protection against dangers to life and health not less efficient than that provided in the said sections.

23. If it appears desirable on account of the special circumstances of the works, or in the interest of the workers, the Federal Minister of Labour may authorize further exceptions to particular provisions of these Regulations.

24. The power of the competent authorities to make more stringent regulations for the protection of the life and health of workers by way of instructions for individual establishments under Section 120*d* and 120*f* of the Industrial Code, shall not be affected by the foregoing provisions.

25. A written or printed copy of these regulations and of the Notice shall be affixed in a conspicuous place in each workroom and in the cloakroom and messroom; and, in addition, a board on which the times for beginning and ending work, and the breaks allowed to workers, are inscribed shall be similarly displayed in a conspicuous place in rooms in which white lead, lead sulphate, litharge or red lead is manufactured.

26. Work shall not be begun in new establishments for the manufacture of the substances specified in Section 1, paragraph 1, until the erection of the said establishments has been notified

*See footnote, p. 230.

to the industrial inspector concerned. The said inspector shall on receipt of the notification, ascertain by personal examination that the installation of the establishment complies with the regulations in force.

27. The foregoing regulations shall come into force on the day on which they are promulgated. The regulations issued in the notification of the Federal Chancellor, dated 26th May, 1903 (R. G. Bl., p. 225), shall simultaneously be repealed.

In cases in which structural alterations or material alterations in the plant are necessary in order to comply with this notification, the high administrative authority, after consultation with the workers' committee and the industrial inspector concerned, may allow a period of not more than three years for the said alterations.

5. Bekanntmachung über das Bleimerkblatt. Vom. 27. Januar, 1920. (Nr. 7269).

Notification respecting the Lead Notice. Dated 27th January, 1920.

The Notice to be issued under Section 11 of the Order respecting the installation and working of establishments for the manufacture of lead colours and other lead compounds, dated 27th January, 1920, shall read as follows:

Lead Notice.

Any person who in the course of his occupation comes into contact with lead or lead compounds (with the exception of galena) or substances containing lead, is exposed to the danger of lead poisoning. This danger is the greater owing to the fact that the poison does not betray its presence to the worker either by smell or by taste (except in the case of acetate of lead) and thus he may take it into his system unawares.

Lead poisoning is usually caused by lead, which is left sticking to the hands or clothes or beard, being taken into the mouth in very small quantities during eating, drinking, smoking, snuff-taking, or chewing tobacco, or inhaled in the form of dust during work.

The lead gradually accumulates in the body, and symptoms of lead poisoning appear sooner or later according to the quantity of the poison absorbed and the resisting power of the worker.

A blue-gray line on the gums ("blue line"), close to the teeth, is a sign that lead has already been absorbed by the body in considerable quantities, and that disease due to lead poisoning is about to declare itself. The presence of a blue line should therefore cause the worker to take more care than before that he absorbs no further quantities of lead in the course of his work; it is at this stage possible that he may escape actual illness. On the other hand, it often happens that within a very short time, but sometimes not for some weeks or even months, lead poisoning specifically declares itself, and this is usually very painful, protracted, and in certain cases dangerous to life.

Prevention of lead poisoning.

Care and cleanliness are the surest protection against lead poisoning. In particular, the following directions should be observed:

- (1) Hands and working clothes must during work be protected as far as practicable from contamination with lead, lead compounds, or substances containing lead. The nails must always be kept short. Smoking, snuff taking, and chewing tobacco during work must be discontinued. Cigarettes, tobacco, pipes and other smoking utensils must not be brought into the workrooms.
- (2) Workers must not take food and drink, or leave the workplace, till they have removed their working clothes and thoroughly washed their hands with soap and nail brush. The face, and especially the beard, must also be carefully cleansed if they have been soiled during work.
- (3) The prescribed working clothes must be worn for all work in connection with lead. Respirators, damp sponges or bandages covering mouth and nose must be worn during all work involving the raising of dust, unless the dust is immediately and completely removed by exhaust ventilation, in order to prevent the inhalation of dust containing lead.
- (4) The widespread belief that the regular use of certain remedies (iodide of potassium), sulphur tabloids, Glauber salts and other aperients), or milk drinking, is sufficient to prevent lead poisoning, is incorrect. On the other hand, a certain value must be attached to nourishing and fat-forming diet, and to that extent to milk drinking also. The use of alcoholic drinks, especially brandy, facilitates the attack of lead poisoning, and is therefore to be avoided.
- (5) Exercise in the open air, gymnastics, baths, etc., increase the resisting power of the body, and should therefore be encouraged as much as possible.

If a worker who comes into contact with lead, lead compounds or substances containing lead, becomes ill, he should immediately in his own interest and in that of his family, consult a doctor and at the same time tell him that he has come into contact with lead during his work.

6. Bekanntmachung über die Dienstanweisung für die ärztliche Untersuchung von Bleiarbeitern. Vom. 27. Januar, 1920. (Nr. 7270.)

*Notification respecting Service Instructions for the Medical Examination of Lead Workers.**Dated 27th January, 1920.*

In pursuance of Section 17 of the Order respecting the installation and working of establishments for the manufacture of lead colours and other lead compounds, dated 27th January, 1920, the Federal Minister of Labour issues the following service instructions:

Service Instructions for the Medical Examination and Supervision of the Health Workers in Establishments for the Manufacture of Lead Colours and Other Lead Compounds.

I.—EXAMINATION PRIOR TO ENGAGEMENT.

The medical practitioner must examine every worker before he is engaged for work in any of the undertakings specified in Section 1, paragraph 1, of the Order respecting the installation and working of establishments for the manufacture of lead colours and other lead compounds, dated 27th January, 1920, in order to ascertain whether his health is such as to render him suitable for employment in the establishment. The medical practitioner must, before the examination, ask the worker in what kind of undertaking he has worked hitherto, whether he has ever suffered from lead poisoning before, and what symptoms then appeared.

Women must not be employed in the undertakings specified, except in cleaning the rest room, meal room, cloak room, lavatory and bath room, and in washing and mending working clothes; and male workers under 18 years of age must not be employed in establishments devoted mainly or exclusively to the manufacture of lead colours or other lead compounds (Section 10 of the Order). The medical examination is consequently unnecessary for these workers.

The medical practitioner must regard as unfit for employment any person who has already suffered severely from lead poisoning (e.g., lead paralysis, serious or repeated attacks of lead colic), or who still shows symptoms of lead poisoning, however slight, or who owing to the nature of his previous employment must certainly have absorbed lead, and in whose case the present medical observations and the blood test—especially the presence of numerous basophil granules in the red cells—indicate that the appearance of lead poisoning in the near future is to be feared. Weakly or ailing persons must also be regarded as unsuitable, especially those suffering from pulmonary tuberculosis, from diseases of the circulatory system or of a syphilitic nature, or from inflammation of the kidneys, and persons addicted to drink.

The medical practitioner must, at the close of the examination, instruct the workers found suitable for employment as to the dangers of lead poisoning. His instructions must be based on the popularly phrased lead notice issued by the Federal Minister of Labour. They must include due reference to the special circumstances of the works, namely, the way in which the worker must behave in order to guard against the absorption of lead, and to the symptoms of commencing lead poisoning.

The medical practitioner must, after the completion of the examination, prepare for the employer a written statement of his opinion as to the suitability of the persons examined for employment in the works.

II.—PERIODICAL EXAMINATION OF THE WORKERS.

The medical practitioner must inspect persons employed in the works, at least twice a month in the establishment in which white lead, lead sulphate, litharge, or red lead is manufactured, and at least once a quarter in all other establishments to which the aforementioned Order applies; he must observe symptoms of illness, and especially those of any illness connected with lead and examine thoroughly those cases which seem to him suspicious. (Section 17 of the Order.)

During his inspections, the medical practitioner must ascertain by questioning each worker, whether there are any signs of injury to his health through lead work, or whether he is actually already suffering from lead poisoning. He must thoroughly examine persons whose cases appear to him suspicious in this connection, in a special room set apart for the purpose.

In the course of both the inspection and the examination, the following signs of illness especially must be watched for as symptoms of impending or already existing lead poisoning: viz.: The blue line, pallor, lead discolouration of the mucous membranes, pale yellow colour of the sclerotics, wasting, debility, pains in the head, loss of appetite, constipation and other digestive disorders, attacks of colic, diseases of the circulatory system (arteriosclerosis), arthralgia, disorders of the organs of sense, paralysis, albuminuria, haematoporphyrinuria, kidney disease, increased blood pressure, reduction of the hæmoglobin content of the blood (anæmia), appearance of basophil granular erythrocytes (granular red cells) or other blood changes (polychromatophil erythrocytes, increased number of leucocytes, together with numerous transitional and atypical forms), saturnine encephalopathy, cachexia.

The medical practitioner must carry out the special examinations for the verification of the presence of lead poisoning in accordance with the appended directions.

If the examination establishes the presence of forms of lead poisoning which are dangerous to life or which may become so if long continued, especially saturnine encephalopathy, cachexia, chronic inflammation of the kidneys (not merely albuminuria), or recurrent paralysis, the medical practitioner must send to the employer a written proposal for the permanent exclusion from lead work of the person examined. He shall do the same in a case in which, although only slight lead

poisoning is present, it has developed very soon after beginning lead work, or has recurred at short intervals and with increasing severity, and so indicates the presence of unusually high susceptibility to lead. Permanent exclusion from lead work must be proposed, moreover, in the case of those workers who are found to be suffering from pulmonary tuberculosis or alcoholism, even if they show no signs of the influence of lead, or are not suffering from lead poisoning.

In all other cases of lead poisoning, the medical practitioner must propose in writing to the employer the temporary exclusion from lead work of the persons concerned until the symptoms have disappeared.

If only granular erythrocytes (less than one granular cell in 50 fields of the microscope) are detected on examination—and if other diseases are not present, especially other disorders of the blood supply (such as malaria, pernicious anaemia, leukaemia, cancerous cachexia, nitrobenzol poisoning)—if a worker is found to have a blue line, lead discolouration, or haematoporphyrin in the urine, these symptoms must be regarded as signs of the effects of lead, but the patient should be regarded as not yet suffering from lead poisoning, but rather as a "lead carrier" (Bleiträger). If it is feared, as a result of the medical observations and the blood test (especially numerous granules in the red cells), that a lead carrier will shortly develop lead poisoning, the medical practitioner must in his case also send to the employer a written proposal for his temporary exclusion from lead work until the symptoms have disappeared, and the condition of the blood has improved.

Appendix.¹

Instructions for Diagnosis of Lead Poisoning.

1. Determination of hæmoglobin.

Determination is best carried out by means of Tallquist's hæmoglobin scale. A determination of hæmoglobin of 80 per cent. or less is a sign of anæmia.

2. Examination of the blood for granulated erythrocytes.

A drop of blood is obtained by a small puncture in the tip of the ear which should be sterilized with alcohol or ether. It is thinly smeared between two thin cover-glasses (of a thickness of 0.08 mm.) or better between two slides (objektträgern). After the smear has been allowed to dry in the air it is fixed in absolute alcohol for from 10 to 15 minutes.

The staining may be done in two ways. According to Hamel's method the slide is taken from the alcohol and washed with water; then, while still wet, it is covered for a few seconds with several drops of Löffler's methylene blue; it is washed once more and then dried. According to S. Schmidt's method the slide which has been fixed in alcohol is stained with azure II (Giemsa) solution (0.05 g. in 100 distilled water); then it is washed with water and allowed to dry.

The microscopic examination of the slides is done with 1/12 oil immersion with full exposure and the most careful focussing by means of the micrometer screw. In well prepared slides the red blood cells appear as round discs, blue-green and lying closely together; the mucous of the white blood cells, however, have a pronounced blue colour.

There should be rejected smears which are too thick and in which the red blood cells do not lie side by side, but on top of each other or have the shape of a roll of coins; further, smears in which the erythrocytes have the shape of a thornapple; and finally such smears as are too much or too little stained, these being recognized by the fact that the nuclei of the leucocytes are not sufficiently stained. If basophile granules are present they show themselves in the pale green erythrocytes as very fine blue-black specks or fragments which are either placed around the edge or occupy the whole blood-cell. In pronounced cases, as for instance in lead colic, one or more granulated cells are found in almost every second or third field of vision.

According to the experience of P. Schmidt there is evidence of the effects of lead if in 50 fields of vision—a field of vision brings out on the average 200 erythrocytes—more than 1 granulated cell is to be found.

3. Estimation of blood-pressure.

Riva-Rocci's apparatus and Recklinghausen's armet are used. A blood-pressure of 150 mm. mercury clearly indicates a rise above normal.

4. Examination of the urine for hæmatoporphyrin.

This is best carried out by Garrod's method. To 500 ccm. of urine is added 100 ccm. of solution of sodium hydroxide (10 to 100). If reddish or reddish violet phosphates are precipitated hæmatoporphyrin is in great likelihood present in large quantities, provided that the guaiac blood test turns out negative. In that case all the phosphates are allowed to precipitate, the clear urine is poured off, water is added and precipitation is allowed to take place again in order to remove the alkali. The sediment is filtered onto blotting paper and dried as much as possible (it should be kept for this purpose at the temperature of the room for at least half a day). Then it is gradually dissolved in a mortar with absolute alcohol containing hydrochloric acid in the proportion of 5 to 100; it is allowed to stand a few hours and finally filtered through blotting paper; the sediment is washed with hydrochloric alcohol until the filtrate amounts to 10 ccm.

The clear filtrate is then examined with the spectroscope; if "absorption bands" in orange and, especially, green are visible, then hæmatoporphyrin is present. It should then be diluted with alcohol containing hydrochloric acid in the proportion of 2 to 100, until the bands in the spectroscope disappear. The amount required for the dilution should be noticed. If the green band remains visible in dilutions of 1 to more than 50 (*i.e.*, 10 ccm. of original filtrate, plus 40 ccm. of hydrochloric alcohol) the effects of lead are to be assumed. The spectroscopy should always be done in the same glass cylinder, which should be at least 5 cm. long.

(7) Regulations for the manufacture of Ceramic Transfer Pictures¹

(*Reichsarbeitsblatt*, 1st January, 1923.)

"The German Ministry of Labour has recently issued regulations for the protection of workers who are engaged in the manufacture of transfer papers used in impressing patterns on pottery. The colours used are largely lead colours, and while ordinarily the preparation of the transfer papers is done under a hood with an exhaust for removing the dust, a few colours, especially purple, are dusted on the paper by hand, small pieces of cotton being used for the dusting. The surplus of the lead compound is then removed by careful dusting. Workers engaged in this process are exposed to considerable quantities of lead-laden dust and the following regulations, published in *Reichsarbeitsblatt*, January 1, 1923, have been issued for their protection:

1. *Working rooms.*—This section of the regulations provides that rooms in which powdered lead compositions are used must be large enough to provide a minimum of 25 cubic meters (883 cubic feet) of space for each worker. They are to be separated from other workrooms by solid walls; entrances to the rooms must be kept closed during working hours and when the rooms are cleaned. The walls must have a hard, smooth surface, and must be whitewashed at least once a year, provided they are not painted with an oil paint. In the latter case, the paint is to be renewed as soon as it begins to crack or peel. Floors must be smooth in order to permit easy removal of dust.

The workrooms are to be cleaned at least twice a day, and they must not contain any equipment which is not necessary for the work in hand. Stocks of paper in excess of the daily requirement may not be stored in these rooms.

2. *Machines and equipment.*—All machinery used in preparing the pictures must be provided with hoods and equipped with suction devices. As the dust is removed, it must be conducted into a closed chamber, and must there be precipitated. The utmost care is to be used when it is necessary to clean the hoods or the suction devices. All brushes and cloths used in cleaning must be washed immediately after use. Where it is not possible, in a certain operation, for an employee to work under a hood, he must be furnished with a suitable device to protect his nose and mouth, and these protectors must be kept where they are free from dust, and they must be cleaned immediately after use.

3. *Dressing and wash rooms.*—All persons handling lead-containing powders must be provided with a place to dress and wash outside of the workroom. Their work clothes must be kept separate from their street clothes. Facilities must be provided for the workers to take a bath at least twice a month.

4. *Outfits for workmen.*—Workmen are to be furnished gratis with washable working clothes, which must close tightly at the wrists and at the neck. Furthermore, each worker is to be supplied with a drinking glass, a brush for cleaning the finger nails, and a towel.

5. *Eating.*—Workmen may not take food into the workrooms, nor may they eat or drink there. They may not lunch in their working clothes, nor may they take their meals in another part of the factory until they have freed their hair from dust, carefully washed their hands and faces, and rinsed their mouths. It is recommended that smoking, chewing, or snuffing tobacco while working be prohibited.

6. *Selection and instruction of the workmen.*—It is recommended that the minimum age for persons employed in handling lead-containing powders be placed at 20 years. No worker may be employed for this type of work until he has had a physical examination and has been instructed by a physician as to the dangers of lead poisoning. Further, the employer must supply each workman with a memorandum upon the subject of the dangers of his occupation.

7. *Medical supervision of the workmen.*—The factory is to be visited not less than once in three months by a duly appointed physician, whose duty it shall be to examine all workmen and to examine closely those who give indication of lead poisoning. Upon the recommendation of the physician those workmen who are found to be suffering from poison are to be relieved from this type of work until they are wholly recovered and those especially susceptible to lead poisoning are to be permanently excluded from work requiring contact with lead compounds.

The employer is obliged to keep a permanent record, either in the form of a book or of a card index, of the physical condition of each workman and of the changes in the personnel of the department. This record must be shown to the physician and to the factory inspection official,

¹ Abstract from Month. Lab. Rev., U.S. Bur. Lab. Stats., April, 1923, XVI, No. 4, pp. 129-131.

upon request. The employer is responsible for the completeness and accuracy of all entries made in the book or on cards of record. The record must contain the following information:

1. Name of the person keeping the record.
2. Name of the physician.
3. Family and Christian name, age, address, date of employment and of termination of services of each worker, as well as the kind of work done by him.
4. Result of the examination made at the time of employment.
5. Date and nature of each illness, together with a statement of the physician as to whether or not the illness was connected with lead poisoning.
6. Date of recovery.
7. Dates and results of the prescribed, regular examinations."

(8) Notice to File Cutters¹

(Compiled by the Imperial Board of Health and incorporated in the Ministerial Decree of the 11th April, 1907.)

The use of lead or lead compounds for "beds" has repeatedly caused cases of lead-poisoning in file-cutting establishments. Even those made nominally of tin contain a very considerable proportion of lead, and are therefore also dangerous to health.

File-cutters are in the greater danger of contracting lead poisoning the higher the proportion of lead in the bed which they use.

Lead poisoning is usually caused amongst them by metallic lead (however small the quantity may be) being taken into the mouth owing to the hands being dirty when eating or drinking or in smoking, taking snuff, or chewing tobacco.

The effects of this absorption of lead do not show themselves immediately; they more commonly appear after the lapse of weeks, months, or even years, when the particles of lead absorbed into the body have accumulated to such an extent that they are capable of producing symptoms of poisoning.

What are the signs of lead poisoning? The first signs are commonly a blue-gray line on the gums, called the "blue line," and anemia, manifesting itself in a paleness of the face and lips. Subsequent symptoms of the disease are very varied. Most frequently lead colic occurs; the person affected feels violent, convulsive pains (colic pains) in the abdomen, emanating from the region of the navel; the abdomen is contracted and hard; with this there is frequently sickness and constipation, seldom diarrhoea. In other cases paralysis asserts itself, which generally affects those muscles which are used in extending the fingers and occurs mostly in both arms; in exceptional cases other muscles in the arms, or muscles in the legs or larynx are also attacked. Sometimes lead poisoning declares itself by violent pains in the joints; the knee-joints are mostly attacked, more seldom joints in the upper extremities. In especially severe cases symptoms of brain disease appear (violent pains in the head, general convulsions, complete unconsciousness, or great restlessness, blindness). Finally, lead poisoning may result in the severe kidney disease known as contracted kidney and in gout. Miscarriages and still-births are frequent amongst women suffering from lead poisoning. As a result of lead poisoning, children born alive are subject to an increased mortality risk in their earliest years. Children nursed by women suffering from lead poisoning are poisoned by the milk taken into their systems.

Except in those severe cases accompanied by brain symptoms, which not infrequently end fatally, lead poisoning can usually be cured if the persons affected are able to avoid exposure to further injurious effects from the lead. The cure takes several weeks, or, in severe cases, even months. The surest protection against lead poisoning is afforded by cleanliness and temperance. Persons who, without being exactly drunkards, are in the habit of taking alcoholic drink in large quantities, are more exposed to the danger of lead poisoning than the more temperate. Brandy should not be taken, especially during working hours. As regards cleanliness, file-cutters using lead beds should be especially careful, and to this end should, above all, observe the following rules:

- (1) Since it is impossible altogether to avoid contaminating the hands with metallic lead, smoking and tobacco chewing and the taking of snuff should be discontinued during working hours.
- (2) Workpeople should not take food and drink, or leave the workplace before they have thoroughly washed their hands with soap and, if possible, with pumice stone or marble soap. If, in exceptional circumstances, drink must be taken during work, the rims of the drinking vessel should not be touched with the hands.
- (3) If a file-cutter working on a lead bed is taken ill, in spite of these precautions, with symptoms which arouse suspicions of lead poisoning (*see above*), he should immediately, in his own interest and that of his family, consult a doctor, and tell him at the same time that he has had to work on beds containing lead.

¹ Gilbert Stone, *Laws and Regulations relating to Lead Poisoning*, 1922, pp. 161-162.

CHAPTER VI

AUSTRIA

(I) Scope of the lead laws

The following legislation is in force:

- (1) Regulations regarding use of lead paints. 15. 4. 08.
- (2) Order relating to lead and zinc-smelting works. 22. 7. 08.
- (3) Health and safety regulations relative to industrial concerns in which printing, lithography and type-casting are carried on. 22. 8. 11.
- (4) Decree relating to the protection of workmen employed in printing and lithographing works and type foundries. 17. 7. 12.

It has not been possible to ascertain what further legislation exists. As regards that which is here reproduced, it is very similar in principle and detail to that enacted in Germany and Great Britain.

(II) Text of the lead laws

(1) Use of Lead Paints, Etc.

(Regulations issued by the Ministerial Order of April 15, 1908.)¹

(R.G.B. No. 81.)

I.—SPECIAL REGULATIONS FOR INDUSTRIAL WORKSHOPS AND WORKPLACES.

Regulation 1.—Industrial workshops, places intended for the processes of painting, distempering and varnishing, in which white lead or compounds containing lead are used, shall, as far as new premises are concerned, comply with the requirements of the Ministerial Order of the 23rd November, 1905, R.G.B. No. 176. As far as existing premises are concerned, these shall be equally spacious and capable of being well ventilated and heated. In every case the walls and floors of the before-mentioned workplaces, if closed, shall have a jointless impervious surface. These workplaces shall be kept clean, and the cleaning shall always be done by wet methods after work has ceased.

Regulation 2.—On premises referred to in paragraph 1, where more than 20 workers are employed in the processes of distempering, painting, and varnishing, the contractors shall place at the disposal of such workers special places capable of being warmed for washing and dressing, furnished with conveniences for the storage of clothing, and meal rooms, and shall arrange for these places to be always kept clean.

II.—SPECIAL REGULATIONS FOR PROCESSES.

Regulation 3.—In the industries of painting, distempering, and varnishing, and in all industries in which the processes of painting, distempering, and varnishing are carried on, colours and putties containing lead shall be stored and used exclusively in vessels and receptacles on which the fact that the contents contain lead is indicated in a clear and intelligible way.

Regulation 4.—No white lead or other colours and putties containing lead shall be used for internal painting when carried on for the purposes of trade.

For the purposes of this regulation, "internal painting" means such painting as is not continuously exposed, or specially designed to withstand exposure, to the direct influence of the weather.

Provided that this regulation shall not apply to the process of laying on a first "priming" coat over old lead paint, when pure white paint is being renewed: or to the process of laying on paint which is frequently exposed to the influence of aqueous or other vapours.

The industrial authorities, when establishing the precautionary measures elsewhere stated, may grant an exemption permitting the use of the substances named in paragraph 1 of the regulation for internal painting in the case of work which would otherwise not be carried out in this country.

Regulation 5.—No women or young assistants shall be employed in the processes of painting, distempering, and varnishing where the use of white lead or lead compounds is permitted, or conditionally permitted, in pursuance of Regulation 4.

Young assistants shall not be employed in the process of cleaning the places named in Regulation 1, or the overalls named in Regulation 8. Overalls shall always be cleaned by a wet method. Provided that apprentices over 14 years of age may be employed, for not more than

¹ Reports of the Departmental Committees on Danger in the Use of Lead, etc., Vol. III, 1920, pp. 10-12.

six weeks, in connection with the processes mentioned in the first paragraph of this regulation in so far as is necessary for the completion of their education as apprentices.

Regulation 6.—No assistant known to the employer to have suffered from lead poisoning shall be re-employed in processes in which white lead or lead compounds are used, or in cleaning the workplaces indicated in Regulation 1, or the overalls indicated in Regulation 8, without a medical certificate stating that he has recovered and is fit for such employment.

Regulation 7.—White lead or lead compounds shall not be pounded or ground or mixed with oil or varnish by hand, but entirely by mechanical means. In the above operations, and in the processes of pouring such material into receptacles or from one receptacle to another, the workers shall be completely protected against the generation of dust, and the escape of dust into workplaces shall be prevented. Provided that each worker may, when necessary, mix by hand in any week, 3 kilogrammes (about 7 pounds) of red lead, and not more than half a kilogramme (about 1 pound) of any other lead colours, except white lead.

No dry lead paint or putty shall be rubbed down or pumice-stoned unless it has been previously moistened. All debris produced in the process of rubbing down shall be removed while still moist.

When the processes mentioned in Regulation 4, paragraphs 3 and 4, are carried on in buildings and not in the open air, they shall be carried on in places set apart for that purpose in which a notice shall be affixed clearly stating that white lead or other lead compounds are used therein.

Regulation 8.—The contractor shall see that all persons who use white lead or other lead compounds shall wear overalls and head coverings, which shall be cleansed as required. A contractor who, in his business employs more than 20 workers, shall supply the overalls and head coverings necessary for the workers in question, and shall provide for the regular cleansing of these overalls and head coverings.

The contractor shall also provide for all persons who use white lead or other lead compounds a sufficient supply of water (for drinking and for washing purposes), washing utensils, brushes, soap, and towels, which shall be maintained in suitable condition. He shall also provide respirators for all persons who use white lead or other lead compounds in processes entailing the generation of much dust.

Regulation 9.—No white lead or other lead compounds shall be stored, nor shall any process in which these materials are manipulated be carried on, in the living rooms or bedrooms set apart for apprentices.

Regulation 10.—All persons using white lead and other lead compounds shall wear the overalls and head coverings provided and prescribed, and shall wear respirators when engaged in processes entailing the generation of much dust. They shall also thoroughly wash their faces, mouths, and hands before meal times and at the termination of employment. No such worker shall partake of spirits or tobacco (cigars, cigarettes, pipe tobacco, chewing tobacco or snuff) in the workplaces.

Food and drink shall not be kept in the workrooms, and shall only be consumed during the prescribed meal times outside these workrooms, and only in the special meal rooms where such are provided.

III.—REGULATIONS RESPECTING SPECIAL INSPECTION.

Regulation 11.—Wherever white lead or other lead compounds are used, a copy of this Order shall be affixed in an easily accessible place and maintained in a legible condition.

Every person brought in contact with white lead or lead compounds shall, at the commencement of his employment, be furnished with a copy of the leaflet printed as a supplement to these regulations, and the name of all such workers shall be entered in a special register.

The employer shall, on the first appearance of lead poisoning, provide that any such worker is at once notified to the surgeon of the Invalidity Bureau.

Where more than 20 workers are employed, the employer shall provide that all workers brought in contact with white lead or other lead compounds shall be examined by a surgeon for signs of possible lead poisoning once at least in every three months, and the date of each visit of the examining surgeon and the result thereof shall be entered in the register prescribed in Regulation 2. These registers shall be produced to the government inspectors on demand.

IV.—PENALTIES.

Regulation 12.—Infringements of this Order, which are not punishable under the general penal code, or as infringements of The Factory Act, shall, in accordance with the Ministerial Order of 30th September, 1857, R.G.B. No. 198, be referred to the Penal Department.

V.—COMMENCEMENT OF ORDER.

Regulation 13.—This Order shall come into force on the 1st April, 1909.

Leaflet.

1. Every kind of work in which lead or lead compounds are used may cause lead poisoning.
2. Lead poisoning is caused when lead colours are introduced into the mouth, even in small quantities, by eating and drinking with dirty hands, beard and clothing, or by smoking, taking snuff, or chewing tobacco; when they are breathed in the form of dust; or when they gain access to the body in any manner.

3. The effects of lead poisoning may not show themselves until the particles of lead have sufficiently accumulated in the body to cause symptoms of poisoning. Early signs of lead poisoning are a bluish-grey line on the gums, the blue line, and a peculiar pallor of face, especially in the lips. Among other symptoms of the disease the following require special note: Painful spasms in the abdomen, originating in the region of the navel (so-called lead colic), frequently accompanied by vomiting and by constipation or, less frequently, diarrhoea; pains in the joints and paralysis, headache, general cramps, unconsciousness, grave derangement of the system, even blindness and severe brain symptoms, which not infrequently prove fatal.

4. With prompt and suitable medical treatment, lead poisoning is usually curable, if the patient can avoid further exposure to lead.

5. Lead poisoning can be guarded against by taking the following precautions:

- (a) Thorough cleanliness must be observed both in and out of working hours; and in particular any generation of dust in the course of work must be avoided.
- (b) When at work overalls and head coverings must be worn, and changed at least once a week. Outdoor clothing must, during working hours, be kept free from dirt and dust.
- (c) Workers who use lead paint should take nutritious and, as far as possible, fatty food, and abstain from spirits.
- (d) The use in workplaces of spirits, and of every form of tobacco (cigars, cigarettes, pipes, chewing tobacco, and snuff) must be absolutely avoided.
- (e) Food and drink, brought or sent to workplaces, must be so kept as to be perfectly protected from dust and dirt. They should only be consumed at the prescribed meal times and in the special meal rooms where such are provided.
- (f) Before every meal time and before the close of work, the hands and face, especially the beard and mouth, must be thoroughly washed with warm water; the mouth must also be rinsed out before drinking.
- (g) Washing, wherever possible, must not be carried out in the workplaces.
- (h) Pipes, tobacco, and eatables should not be kept in the overalls.
- (i) Every worker should take a bath at least once a week, when the hair of the head and beard must be carefully cleansed.
- (k) Every worker must, on the least sign of illness, consult the doctor, and at the time call his attention to the fact that he has had to work with lead products.

(2) Order relating to Lead and Zinc-Smelting Works¹

(22nd July, 1908.)

In pursuance of section 220 of the General Mining Act and of section 1 of the Act of April 30th, 1870, R.G. Bl. No. 68, the Minister of Public Works, in agreement with the Minister of the Interior, issues the following regulations for lead and zinc-smelting works established in accordance with the General Mining Act:

1. In designing new works for lead and zinc smelting the direction of the prevailing wind shall be taken into account, so that the gases and vapours emanating from the furnaces shall not be conducted to other workplaces, dwelling houses and similar buildings in the neighbourhood of the works.

The chimneys shall, as far as is practicable, be erected outside the works, and shall be of such a height that gases and vapours drawn off through them shall be carried away in as harmless a manner as possible.

So far as this appears to be necessary, in view of special circumstances, such as the locality where the works are established and the nature of the gases and the vapours arising in the course of the smelting operations, condensing apparatus shall be instituted in accordance with any instructions issued by the mining authorities, through which the gases and vapours arising in the smelting of the ores shall be made to pass before escaping into the open air.

As far as is practicable, arrangements shall be made whereby operations may be suspended in certain parts of the works or in connection with certain appliances for the purpose of carrying on cleaning and repairing work, independently of the rest of the works.

2. The rooms where lead ore or zinc ore containing lead is roasted or zinc ore calcined, or where lead ore is slabbled or smelted, lead refined or desilverized, litharge or other lead oxides produced in the smelting processes are ground, mixed, stored or packed, rough zinc or zinc refuse distilled and zinc dust worked off, must be roomy, high, well lit and so arranged that they shall be adequately and constantly ventilated. If sufficient light cannot enter from the sides of such rooms they shall be provided with sky-lights.

In rooms where lead oxides are manipulated, the openings for admitting light must be at least 4 metres high.

In order to prevent an accumulation of dust, there shall, as far as possible, be no sills or recesses in the workrooms.

3. The floors of the rooms specified in regulation 2 shall be level and firm, and must be constructed with concrete, iron plates, tiles or similar material from which dust may be easily removed by a wet process.

¹ Gilbert Stone, *Laws and Regulations relating to Lead Poisoning*, 1922, pp. 183-189.

In order to prevent the accumulation of dust, the surface of the walls in the said rooms must be smooth and they shall be cleaned by a wet process once a year.

In rooms where dust containing lead oxide is liable to be engendered to a great extent, the walls must be covered with smooth cement or the masonry lime-washed or painted in oil. In other rooms, if the walls are of masonry, they must be covered with whitewash, renewed at least once a year.

The floor must always be kept in a damp condition, and must be cleaned at least once a day. This provision shall also apply to rooms where charging or other processes in the course of which dust containing lead is produced are carried on.

4. All apparatus used in lead and zinc-smelting works shall, as far as possible, be so placed that they shall be approachable from all sides, so that it may be possible for every workman to carry on his work in a comfortable position. Reverberatory, distilling and refining furnaces and plant for Pattinson's and Parkes' process, etc., must be so arranged that the workmen shall not, in the course of their work, be subjected to heat radiating from several sides.

The joints of apparatus wherein dust containing lead or gases and vapours containing lead are generated must, unless the escape of dust or gases and vapours, as the case may be, is prevented by their method of construction and use, be so contrived that dust, gases and vapours are prevented from escaping into the workrooms as far as is practicable.

5. A sufficient supply of good, fresh and, where possible, running drinking water to which dust cannot penetrate, shall be kept in readiness about the workrooms for workmen employed in the rooms specified in regulation 2, in such a manner that they shall be able to obtain it conveniently at any time without going out of doors. Drinking water brought in vessels shall only be provided in cases where it is not possible to lay on water in the works in question at all, or not without disproportionate expense. In such cases only closed vessels shall be used for drinking water. Such vessels shall be thoroughly cleaned every day and scalded out with hot water or steam at least once a week. If drinking water is brought in vessels provision must be made for renewing it several times during each shift.

6. Hydrants fitted with hoses and sprays, or some other suitable arrangements for cooling the heated material, damping the dust, etc., must be provided in the rooms specified in regulation 2, and also in all rooms where work is carried on in the course of which dust is generated, unless the mining authorities shall sanction exceptions in any particular case.

7. Unless the materials to be ground are damped to such an extent as to prevent the generation of dust, lead and zinc, ores and other smelting products containing lead, shall only be ground in apparatus such that the dust is prevented from escaping into the workrooms by means of exhaust draughts. Sacks in which lead or zinc ore or other materials containing lead are packed shall not be dusted or cleaned, except in apparatus which are impervious to dust or by washing.

8. If the materials containing lead with which the furnaces, retorts and muffles are loaded are oxidized and liable to give rise to lead dust, they must, so far as is consistent with further operations, be damped for the purpose of preventing the generation of dust, before being mixed with other materials and being put and smelted in the aforesaid apparatus.

9. Dust, gases and vapours containing lead which escape from furnaces, retorts, converters, distilling apparatus, tapping apparatus, slag crucibles, cinder tubs, refining and Pattinson melting pots, the red-hot refuse, etc., must by means of suitable arrangements be caught, and be removed from the workroom in a harmless manner.

If workmen are obliged to enter condensing chambers, dust conduits, and burnt-out furnaces, such places must first be sufficiently cooled and ventilated.

10. Where litharge and other substances containing lead, such as zinc dust, are ground and packed, and where any other occupations are carried on in the course of which dust containing lead is generated, exhaust draughts and drawing-off apparatus and other suitable apparatus must be provided to prevent the entry of dust into the workroom.

The grinding and packing of the said substances shall be carried on in separate rooms, and shall, as far as possible, not be done by hand.

11. For the purpose of investigating the contents of the air in various parts of the works specimens thereof shall, on the special order of the mining authority, be taken and analyzed by suitable persons for the purpose of ascertaining the amount of lead it contains either in special cases or at stated intervals according to the instructions of the said authority.

A current record shall be kept of the said analyses which shall be laid before the mining authority or its representative, on demand.

12. No woman of any age or workman under the age of 18 years shall be employed in the rooms specified in regulation 2, or in the preparation of test bottoms, or the charging or emptying of furnaces, nor in the condensing chambers or conduits, and in cleaning and breaking-up furnaces, in transporting the condensed dust, in repairing furnaces, nor in any other work in the course of which lead dust is generated.

13. Workmen employed at reverberatory and slag furnaces, converters, Pattinson and refining melting-pots, distilling apparatus and refining hearths, in clearing out and condensing chambers and conduits containing humid condensed dust, in transporting lead dust and in preparing the test bottoms where the substance containing oxide of lead are used, shall work in 8 hour shifts only. In the case of workmen employed at reverberatory and slag furnaces, converters, Pattinson and refining melting pots in works where such apparatus is only used periodically and during not more than 10 weeks in any one year by the same man, a 12 hours' shift containing 10 hours actual work may be substituted for the 8 hour shift.

Smelters shall not be employed in American furnaces for more than six hours in any one shift; work in the processes in question shall, as far as practicable, be so divided that after every period of two hours' work each workman shall have 2 hours' rest.

The length of each shift for workmen employed in clearing out the condensing chambers and conduits containing dry, condensed dust, grinding and packing litharge and similar substances containing lead, such as zinc dust, shall, unless the work is entirely done by machinery, not exceed 6 hours, during which the actual time worked shall not amount to more than 4 hours. This period of employment shall, as required, be interrupted by ample intervals for washing and rest. There shall be periodical changes in the staff employed in such work, so arranged that in any one week no workman shall be employed therein for more than three days.

Workmen employed in cleaning and breaking up furnaces and in repairing furnaces in zinc smelting works, shall only be employed in 8 hour shifts. In the event of such work being done in lead smelting works, the provisions contained in the third paragraph of this regulation shall apply to the workmen so employed.

After consultation with the workmen's representatives, the mining authorities in agreement with the Provincial Government and in conformity with the applicable statutory provisions, may permit, subject to revocation at any time, exceptions to the restrictions on the length of shifts and periods of employment laid down above, if the results of investigations made and the report of the medical practitioner, who must be consulted on the matter, show that the lengthening of the shifts and periods of employment will not endanger the health of or cause any great hardship to the workmen concerned.

14. It shall be the duty of the owner of works to provide working clothes, consisting of at least trousers, a blouse and a cap, for workmen engaged at the apparatus and in the processes named in regulation 13, and in all other occupations in the course of which dust containing lead is generated.

Where hygienic consideration so requires, the workmen shall also be provided with gloves.

The owner shall furnish workmen employed in cleaning out condensing chambers and conduits, or in similar occupations, in the course of which they are exposed to an exceptional extent to the effects of dust containing lead, with dust guards (respirators, sponges, etc.), covering the mouth and nose.

15. The clothes, gloves and dust guards prescribed in regulation 14 must be furnished in proper condition and sufficient quantity to workmen employed in the occupations concerned. The owner shall see that the working clothes are regularly cleaned, washed at least once a week, and repaired whenever necessary; he shall also see that the dust guards shall always be in a condition fit for use.

Working clothes and dust guards must not be stored in the workrooms.

16. In all works there shall be provided in connection with the workrooms for the use of the workmen a special washing and bathroom, a cloakroom for dressing and undressing, and a messroom, which must be protected against dust.

These rooms must be cleaned and always kept free from dust by being washed with clothes or sluiced with water, and they must be heated in the cold season. In new premises the bathroom shall be contiguous to the washing room.

The floor of the washing room and bathroom must be impervious, and the walls must be washable to a height of at least two metres. The washing room must be fitted with hot and cold water taps, and with the necessary basins, which must be easily cleaned. The necessary number of shower baths with hot and cold water and bathing tubs must be provided. Water glasses, nail brushes and soap must be kept in readiness in the washing and bathroom. Every workman who, in conformity with regulation 20 (4), is obliged to use the bath must be given a clean towel at least once a week.

The washing and bathing installations must always be in a condition fit for use. Every workman must be given an opportunity of using the washing and bathing arrangements.

Working clothes and clothing removed before starting work shall be kept separately in cupboards provided for the purpose or suspended at a height in the cloakroom. Clothing must not be so suspended except in rooms which are entirely free from dust.

In the messroom arrangements for warming food shall be provided in a suitable place.

With respect to works already in existence before this Order comes into operation, the mining authority shall, in special cases, have power to relax the requirements relating to the provision of washing and bathrooms.

17. A superintendent, or some other responsible official, shall be appointed by the management of the undertaking to see that the washing, bath, cloak, and messrooms are kept in proper condition; the said official shall report to the manager, or his representative, any defects in these rooms or their installations with which he cannot deal himself, in order that they may be remedied.

18. Only such persons shall be employed in lead and zinc smelting works as have been certified by a medical practitioner to be suited to the work offered.

It shall be the duty of the owner to cause workmen employed at the apparatus and in occupations named in regulation 3 to be medically examined at least once a month, especially with a view to detecting any symptoms of lead poisoning.

Workmen employed in other occupations in smelting works shall undergo this examination at least once a quarter.

Workmen who, according to the medical opinion, are suspected of suffering from lead poisoning, shall not be allowed to work in the rooms specified in regulation 2, nor in the manner contemplated in regulation 13.

With respect to workmen who are recognized to be suffering from lead poisoning, if the examining medical practitioner shall consider that they may still be employed in smelting work at all, they shall only be employed in the processes specified by him.

Workmen who are particularly susceptible to the effects of lead shall be permanently excluded from employment in the occupations specified in regulation 2 and in the manner contemplated in regulation 13.

19. In order to supervise the health of workmen employed in smelting works, a register shall be kept at every works containing the following particulars respecting every workman:

- (1) His forename, surname, age and residence, the date when he entered and left the employment, his medical condition when taken on, and the nature of the work allotted to him.
- (2) The days on which the medical examinations prescribed in the second and third paragraph of regulation 18 are held, and the results thereof, and the name of the examining medical practitioner;
- (3) In the event of any workman falling ill:
 - (a) The date on which he is taken ill and the nature of the illness.
 - (b) The date of his cure.
 - (c) The nature of the lighter work, if any, offered to the workman after he is cured.

The entries in the register respecting the results of medical examinations shall be signed by a medical practitioner entrusted with the medical examinations as being correct, unless he shall have made such entries himself.

The register shall be laid before the mining authority and the representatives of the Provincial Government, on demand.

20. The owner shall include the following provisions in the rules of service (regulation 200a, B.G.), issued for the workmen employed in his smelting works:

- (1) The workmen shall, in conformity with the rules, use the working clothes, gloves, and dust guards in the rooms and occupations for which they are prescribed (regulation 14); they shall remove them when the shift or the work is finished, and put them away in the prescribed places. Clothing shall only be put on and taken off in the cloakroom; in no circumstances shall the said clothing be taken into messrooms or dwellings.
- (2) The workmen must not take food or drink into the workrooms. Meals must not be taken in the workrooms, but in the messrooms.
- (3) Every workman must, before taking any meal and also after the termination of the shift, thoroughly clean his hands, face, mouth and teeth; such cleaning must always be done in the washing rooms.
- (4) All workmen employed in occupations where, in accordance with regulation 13, paragraphs 3 and 4, the length of each shift must not exceed 6 hours, and the period of actual work must not amount to more than 4 hours, must take a bath once daily and all other workmen employed in the smelting works must take a bath whenever necessary, and at least once a week, at the works on each occasion on the termination of a shift. Only workmen for whom bathing has been medically certified to be unsuitable shall be freed from this obligation.
- (5) Cigars and cigarettes must not be smoked in any workroom, and pipes must not be smoked nor tobacco chewed during the following processes: Clearing out condensing chambers and conduits, cleaning and breaking up furnaces, working at American furnaces, distilling zinc, sifting, grinding, packing litharge or other products containing lead.
- (6) Workmen who, in spite of repeated warnings and of the penalties inflicted in accordance with the rules of service, contravene the foregoing regulations, may be dismissed before the expiration of the contracted period and without notice.

21. The owners must instruct the persons entrusted with the management of the business to insist emphatically on strict compliance with the regulations issued in pursuance of regulation 20, paragraphs 1-5, and to supervise continuously the observance thereof.

The persons so instructed shall, in accordance with the rules of service, be answerable for the observance of the aforesaid regulations.

22. Copies of this Order and of the rules to be issued by the owner in pursuance of regulation 20, shall be fixed in every workroom and in the cloakrooms and messrooms and shall be given to all officials and superintendents in the undertaking, so that they may observe them and give the workmen instructions accordingly.

23. The workmen shall be instructed in a suitable manner in the nature and symptoms of lead poisoning and in the methods whereby they can protect themselves against such poisoning.

24. This Order shall come into operation three months after its publication in the Reichsgesetzblatt; in cases where, for the execution of any of the provisions, buildings or installations have to be constructed, the mining authority shall allow suitable periods of transition.

(3) Health and Safety Regulations relative to Industrial Concerns in which Printing, Lithography and Type-Casting are carried on.¹
(August 23, 1911.)

I. Special measures respecting the condition of industrial workshops, workrooms, and their installation.

1. Wherever it is not otherwise hereafter provided, all rooms in industrial establishments used for the purpose of printing, lithography or typecasting, where such are installed in new premises, shall at least fulfil the requirements in the Ministerial Order of 23rd November, 1905 (R.G. Bl., No. 176), "new premises" within the meaning of the Order being understood to include any change of premises which may necessitate renewal of permission to work in certain premises. Existing premises, other than those that fall within the meaning of "new premises" in this Order, shall have sufficient light, be well ventilated, and be capable of being heated when necessary. Rooms used for the purpose of type-setting, both hand-setting and machine-setting, and the making-up department, shall be well provided with daylight, and a strict fulfilment of all the requirements of hygiene shall be adhered to in regard to artificial lighting.

Rooms in which the undermentioned work is done shall be of such dimensions that every workman employed therein shall have a minimum air-space of 15 cb.m., and a floor-space of 3 sq.m.

The minimum height of these rooms shall be 3 metres, wherever the building regulations do not require more.

The kinds of work referred to are as under:

- (1) The preparation of type metal containing lead (*i.e.*, the melting, mixing, or melting down thereof).
- (2) The making of letters and type material from type metal containing lead.
- (3) Stereotyping and backing clichés.
- (4) Work on type-setting machines, wherever lead-containing type-metal is used.
- (5) All work with lead-containing type-metal (*i.e.*, setting and distributing, sorting, dividing, wrapping, etc.).
- (6) All work with dry lead colour.
- (7) Bronzing with bronzing powders and the cleansing of bronzing machines and their spare parts.

In all other rooms not used for the above-mentioned purposes, an air space of 12 cb.m. and a floor space of 2.6 sq.m. shall be sufficient for each workman.

In certain special and temporary cases the industrial authorities of first instance may permit a closer occupation of type-setting rooms for a maximum period of 60 working days per annum, and of the remaining workrooms for a maximum period of 30 working days per annum, allowing a minimum of 12 cb.m. air space per workman for those included in Part II of this section, and for all others a minimum of 10 cb.m.

In all new premises underground rooms shall be on no account used for work included in paragraph 2 (2)-(7), nor for any kind of printing, except that done by heavy rotary or other specially heavy machinery; while for any other kind of work, underground rooms may only be used when, in cases where their height from floor to ceiling does not exceed 4 metres, at least four-fifths of their height on the window side lies higher than the level of the adjoining soil, but if the height from floor to ceiling exceeds 4 metres, then at least three-quarters of the height must be above the level of the ground.

A workshop already existing and approved on the day that this Order shall come into force shall, on moving out of its rented premises, generally be subject to the same regulations, provided a renewal of license is necessary, although exceptions may be permitted by the political provincial authorities, if the underground rooms in question, in consideration of the special work for which they may be employed, are unobjectionable from the hygienic point of view, and particularly if they receive sufficient daylight and are so situated as to be capable of thorough airing by windows of adequate size that look out direct into the open air, and not on to interior court-yards or yards covered with skylights. However, when the exceptions affect the condition of workmen coming under paragraph 2 (1)-(4) and (6), they shall only be granted when they affect no more than five men in the case of (1)-(2); three men in the case of (3)-(4); and two men in the case of (6).

For certain work that by nature of the conditions under which it has to be done, is inseparable from high temperature and dust, such as the melting of lead or type metal, operating type and line-setting machines, stereotyping, making-up, and polishing the type, etc., a special building or at least a special department shall be provided, which shall be entirely separate from the remainder of the premises and, when it is technically possible, divided into compartments and closed in such a way that neither heat nor dust shall disturb or endanger the health of other workmen not engaged in that particular kind of work.

In addition, type-setting and printing rooms shall, wherever possible, be separated from one another.

Bronzing with bronzing powder shall, wherever technically possible, be done in separate buildings or departments, and wherever done on a large scale, suitable dust-proof machines shall be used.

2. All workrooms mentioned in regulation 1, paragraph 2, and also all other rooms used for the purpose of printing, shall have a firm and smooth flooring, free from joints, which shall

¹ Gilbert Stone, Laws and Regulations relating to Lead Poisoning, 1922, pp. 190-200.

be either painted whenever necessary, but at least twice a year, with a sanitary dust-binding material, or must be easily washable. A good, closely-laid wood floor, except in rooms where work is done of the kind mentioned in paragraph 2 of regulations 1 (1)-(4) and (6), except where it is a question of grinding only small quantities of dry lead colours in the press-room itself, shall be considered as equivalent to such a floor as above described.

In rooms where workmen are, by the nature of their work, obliged to remain standing in the main for lengthy periods in one place, the floor or at least that part on which they stand, shall be made of heat-non-conducting material.

The walls of rooms used for the purpose mentioned in paragraph 2 of regulations 1 (1)-(6), except where it is a question of grinding only small quantities of dry lead colours in the press-room itself, shall be covered with a smooth, crack-free and easily washable preparation to a height of at least 2 metres, or with a coating of oil paint, which shall always be kept in good condition. The remainder of the walls and the ceiling, as well as the other workrooms in general, may be whitewashed, and this shall be renewed whenever necessary.

Respecting the covering of walls with oil paint, the owner of rented premises may obtain an exemption from the industrial authorities when his tenant can prove that he purposes leaving the premises hired by him in a comparatively short time. A sufficient number of spittoons filled with liquid or with moist material, shall be placed in all the workrooms referred to in regulation 1, paragraph 1, and they shall be properly cleansed at least twice a week.

3. In new premises, and also, whenever possible, in old premises, where an average of more than twenty workmen are employed, there shall be sufficient washing and dressing accommodation for all workpeople that come under paragraph 1 of regulation 1; separate lockers shall be provided for the storage of ordinary clothes and those worn in the workshop, while during cold weather the room shall be suitably heated.

In already existing establishments where the installation of such special rooms is not feasible and in all industrial establishments where an average of twenty workmen are employed at least, good tight-fitting clothes-boxes shall be provided. These clothes-boxes shall permit of a complete separation between ordinary clothes and those worn in the workshop.

In industrial establishments in which printing and type-casting operations are regularly carried on, not only by day, but also at night (*i.e.*, between the hours of 8 p.m. and 5 a.m.), the workpeople engaged in work of the nature described in regulation 1, paragraph 1, shall, in addition, be provided with a suitable detached room for meals, and this room shall also be suitably heated during the cold weather.

4. As regards steam boilers and power machines, shafting, work machines and installations, lifts and hoists, and transport arrangements, the provisions of the Ministerial Order of 23rd November, 1905 (R.G. Bl., No. 176) shall apply, except in so far as more far-reaching provisions are contained in the following:

- (a) Every machine shall be provided with a stop-motion lever that shall always be within easy reach of the workman when standing at his usual place before the machine, and quick and easy to operate. This stop-motion lever shall be so regulated and guarded that it shall be impossible for the machine to start of its own accord. Double-feed, flat-bed printing machines and rotary machines shall be provided with such stop-motion levers on both of their two long sides. Special provisions shall also be made in the case of high-speed and rotary machines to prevent premature or accidental starting. When high-speed and rotary machines are driven by electricity they shall be provided with two switches, one for starting, and another for stopping, which shall be placed at a considerable distance from one another.
- (b) Rotary machines shall be provided with a loud signal alarm that shall be easily heard above the noise of the machinery, and which shall be sounded before setting the press in motion.
- (c) Provision shall be made to prevent the high platforms of rotary machines, and also, when necessary, of high-speed machines, on which attendants stand, from giving way.
- (d) Suitable provision shall be made for the transport of heavy lithographic stones and press formes, and for lifting them in and out of the machine; also in fitting up and repairing large presses suitable devices shall be employed for fitting heavy cylinders and other heavy machine parts into their respective places.
- (e) Platen machines shall be provided with devices which shall effectively prevent the risk of injury to the hands of operators when the press is being closed.
- (f) The front part of the slot through which the knife falls in the paper guillotine shall be suitably protected by sheet-iron guard.

5. The deleterious fumes arising from the melting-pots of ovens used for preparing type-metal, stereo plates, etc., and also, when technically possible, from the melting-pots of linotype machines, shall be conveyed by a suitable arrangement directly out into the open air or into a main chimney. All piping necessary for this purpose shall be covered with non-conducting material, so that the heat shall not disturb or endanger the health of the operator.

The melting pots themselves shall also, whenever possible, be covered with non-conducting material.

Suitable large trays or receptacles shall be placed under type-casting and linotype machines wherever their construction shall permit it.

II. *Special industrial regulations.*

6. The manipulation of ink rollers or formes once they are placed in the machines, such as knocking down a block, shall only be done when the machinery is at a complete standstill. This regulation shall be put up in a conspicuous part of the workshop.

All explosive liquids, such as turpentine, benzine, methylated spirit, etc., shall be kept in explosion-proof barrels, and only allowed in the workshops in quantities never more than is necessary for the average requirements of one day.

Women employed at machines shall not wear light, flimsy clothes, nor hanging plaits, nor wear their hair loose when engaged at their work. The sleeves of their dresses shall, when they reach below the elbow, be securely fastened round the wrist.

No rings shall be worn when working at work machines (Carbutschmaschine), rotary or high-speed presses.

A liberal supply of first-aid material, such as cloths, bandages, antiseptic gauze, antiseptics and remedies to stop bleeding shall be to hand.

7. No women workers and boys under sixteen, unless apprenticed, shall be employed in treading platen machines, nor at work mentioned in paragraph 2 of regulation 1, nor at any work where the operator cannot avoid being covered with already ground lead colours, and so made very dirty, such as washing colour rollers and cleaning colour boxes.

The only exceptions to this regulation shall be as under:

- (1) The employment of women of more than seventeen years of age for bronzing;
- (2) The employment of women of more than sixteen years of age for the following type-casting operations: dividing-up, sorting, setting and distribution of type, etc., and also in warehouses and packing operations.

Apprentices under sixteen years of age shall not be employed in bronzing with bronze powder, or blowing out type-cases, and other cleaning operations connected with considerable formation of dust.

8. All workrooms shall be well lighted, heated, and thoroughly ventilated during working hours, and in addition they shall be thoroughly aired out of working hours once a day. Workrooms referred to in paragraph 2 of regulation 1 shall be thoroughly aired out of working hours at least twice a day.

In industrial establishments where workmen mentioned in paragraph 1 of regulation 1 are employed on day and night shifts, workrooms shall have a thorough airing at the end of each shift as well as one during the long pause of each shift.

9. The floors of all workrooms shall be cleaned every day out of working hours, and whenever possible by a wet process.

The washing-rooms, dressing-rooms, and rooms where workmen take their meals mentioned in regulation 3 shall also be kept in a thoroughly clean and proper condition.

That part of the wall which is washable shall be cleaned by a wet process at least once a month.

The type-setting desks and drawers and other installations shall either stand on the floor so that no dust shall collect beneath them, or there shall be sufficient room under them for the floor to be easily cleaned.

Type-cases in continual use shall be cleaned when necessary, but this must be done at least once every three months, while other type-cases that are only used occasionally shall be cleaned thoroughly before use, and the date of the last cleaning shall be clearly marked on each type-case.

The cleaning of type-cases, and also of the standing and permanent formes, shall be done wherever possible with suction apparatus, or by a wet process; in any case, it shall be done in such a way that the operator is protected from the dust formed thereby. Cleaning by means of bellows shall only be done in the open air.

The interior of type-setting desks and drawers shall be cleaned when necessary, but this shall be done at least once every three months, and, wherever possible, with a good suction apparatus.

The whole establishment, including all rooms and, more especially, walls and shelves, shall be thoroughly cleaned twice a year.

When much dust is raised by cleaning, this cleaning shall be done out of working hours.

The use of washing and cleaning materials dangerous to health, especially crude turpentine, is prohibited.

10. The crushing and grinding of white lead and lead compounds, also mixing, kneading and rubbing the same with oil or varnish in the preparation of lead colours, shall only be carried out by means of mechanical appliances, and in such a way only that those employed at the work shall be protected from the dust formed thereby. Workmen shall also be protected from dust in the operation of filling and emptying the different receptacles, and no dust shall reach the workrooms.

Tubs and receptacles used for storing and treating lead colours shall have their lead contents clearly and distinctly marked on the outside.

11. The employer must, by means of suitable notices, require workmen employed in the processes named in regulation 1, paragraph 2, as well as printers and machine operators, to make

use of suitable working clothes, in so far as they have to undertake printing operations with setting material containing lead or with bronze powder, and he must provide those workmen who are employed in the works enumerated under regulation 1, paragraph 2, sub-section (6) and (7), as well as women employed in type-casting, type-casting apprentices and unqualified type-casting assistants, with working clothes, and the first named (regulation 1, paragraph 2, sub-sections (6) and (7)) with head coverings also.

The employer shall also see to it that the clothes provided by him are at his cost, properly washed, and that the clothing and head-coverings used by workmen mentioned in paragraph 2 of regulation 1 (7), when they are regularly employed at bronzing, are freed from dust every day. When bronzing is not done every day, the clothes shall be freed from dust every time they are used.

The employer shall provide all workmen doing work in which a considerable amount of dust is produced, especially bronzing, grinding dry lead-containing colours, etc., with a special dust-proof protector to prevent dust from entering mouth and nose (respirator and so forth); and this protector must always be kept clean.

12. The employer shall provide all workmen employed at work mentioned in paragraph 1 of regulation 1 with sufficient good drinking water; also suitable washing accommodation with running and, wherever possible, warm water, soap, nail brushes, and one clean towel per week for each workman.

As a rule, there shall be at least one wash place for every five workmen.

13. All workmen shall be bound to carry out the directions of their employers respecting this Order, or in default be liable to incur the penalties stated in regulation 17.

Similarly, all workmen employed at work mentioned in paragraph 2 of regulation 1, and foreman printers and machine foremen, when they have to work with lead-containing type-metal or with bronzing powders, shall be bound:

- to wear the clothing and head-coverings, and to use the protective apparatus and safeguards prescribed in regulation II;
- to wash the face, mouth and hands thoroughly, with warm water wherever possible, after work, or even when work is temporarily interrupted;
- the hands especially shall be well cleansed with soap and nail-brush;
- to keep their work-clothes only in the dressing-rooms, or, as the case may be, in the clothes lockers, especially provided for this purpose, as stated in regulation 3;
- to submit regularly to the requisite medical examination, according to regulation 15;
- and at the appearance of the first sign of lead poisoning, or at the order of the periodically visiting medical man, to apply at once to the club doctor.

Workmen employed at work mentioned in paragraph 2 of regulation 1 shall be prohibited from:

- taking or keeping food or alcoholic drink in their workrooms or consuming them there;
- smoking or using tobacco in any form, cigars, cigarettes, pipe-tobacco, chewing tobacco, or snuff, in any part of the workshop except in the rooms specially set apart for this purpose;
- entering the rooms set apart for meals in clothing that has been worn in the workshop or without having thoroughly washed, and expectorating in any part of the workrooms except in those receptacles provided for the purpose.

The employer shall be prohibited from permitting smoking or the use of tobacco in any form by workmen mentioned in paragraph 2, except in drinking and recreation rooms.

III. Regulations respecting special supervision.

14. In all workrooms mentioned in paragraph 1 of regulation 1, the employer shall affix in a prominent position and always keep in a readable condition:

- (1) a copy of this Order;
- (2) a statement, the correctness of which must be certified free of charge by the competent industrial authorities, relating to the length, breadth and height of each particular room in metres, its air content in cubic metres, and the number of workmen that may be permitted to work in the said room according to regulation 1.

The employer shall also be bound to give free of charge to every new workman employed at work mentioned in paragraph 1 of regulation 1 a copy of the Special Notice accompanying this Order as a supplement.

The employer shall endeavour to secure the strict observance of all the regulations of this Order by the workmen, and for this purpose he shall affix notices in convenient places, and also, wherever necessary, appoint superintendents selected from among the workmen.

Notices shall also be affixed in the workshops, giving the names and addresses of the nearest sick-club medical men, as supplied by the sick-club authorities.

15. Medical officers appointed by the Political Authorities of first instance shall examine all workmen mentioned in regulation 13, paragraph 2, employed in establishments in their district or within a radius of 3.8 kilometres, for possible symptoms of lead poisoning, at least once a quarter, and in other establishments at least once a year. The medical officer shall give previous notice of the day and hour of his purposed visit to the employer.

This medical examination shall usually take place at the works out of working hours, either before the beginning or immediately after the end of same, though not after overtime hours. The examination shall only take place during working hours with the consent of the employer. Workmen shall receive no compensation of any kind for the time employed for the purpose of such examination, neither shall any deduction be made from their wages on this ground.

The examining medical man shall inform the employer of the result of his examination, and any persons who may show signs of lead poisoning shall be sent immediately to the sick-club medical man. The result of the examination shall be entered by the medical officer on certain specified forms, to be prescribed for these purposes, and placed before the Industrial Authorities.

Workmen with respect to whom the employer has been informed that they are suffering from lead poisoning, or if the examining medical man has notified symptoms of this disease, shall only be employed again at work mentioned in regulation 13, sub-section (2) by written medical permission.

The workman shall for this purpose hand to the employer a written confirmation of the above, signed by the medical man of the Fund or, as the case may be, of the medical man who is treating him.

16. In case of accident, notice shall immediately be given to the employer either by the workman to whom the accident has occurred, or, if he shall be unable to do so, by eye-witnesses thereof.

IV. Penalties for non-observance.

17. Penalties for the non-observance of this Order are stated, in the Ministerial Order of 30th September, 1857 (R.G. Bl. No. 198), so long as it does not come within the range of the penal or industrial codes.

V. Date of coming into operation.

18. This order shall come into force immediately as regards every workshop that is established after the date when this Order shall be published, while as regards already existing and approved workshops, it shall come into force one year after date of publication.

The provisions of this regulation shall, however, apply only to establishments which are already approved on the date of publication of this Order, in so far as the alterations in the establishments required thereby can be carried through without limiting the rights acquired by the license, unless it is a question of the removal of improper conditions which are evidently endangering the life or the health of the workmen, or the demands therein contained can be carried through without disproportionate expenditure and without undue disturbance of the working.

Notice.

All work in which lead, lead compounds or lead alloys are employed may cause lead poisoning.

Lead poisoning may be caused by lead in any form, even in very small quantities but on repeated occasion, being taken into the mouth or entering the system through the medium of dirty hands, beard or moustache, and clothes, while eating and drinking or smoking, chewing tobacco or taking snuff, or even by being inhaled in the form of dust while working, or in any other manner.

The result of this insidious absorption of lead in small particles only becomes noticeable after a long time when the body has stored up sufficient quantity to produce the customary symptoms of lead poisoning.

The first signs of lead poisoning are a bluish-grey edging around the gums, known as a "dark line on the gums," a typical paleness of the face and especially of the lips, and bad digestion and loss of appetite.

Later symptoms are severe cramp in the stomach, often accompanied by vomiting and irregular action of the bowels, and occasionally diarrhoea (known as lead colic), pains in the joints, symptoms of paralysis, headache, great restlessness, cramp all over the body, fainting, and even blindness and severe brain trouble, that not infrequently terminate fatally.

Lead poisoning may usually be cured if taken in time and with proper medical treatment, provided those attacked by it are able to withdraw from their dangerous employment.

Lead poisoning may be guarded against by carrying out the following:

Instructions for the prevention of lead poisoning.

1. The greatest cleanliness shall be observed at all times, both while at work and out of working hours, and the greatest care shall be taken to raise as little dust as possible.

2. Special working clothes shall always be worn in the workshop, and when employed on very dusty work, workmen shall always wear a head-covering and a respirator or similar apparatus. Such clothing shall be changed at least once a week. Ordinary clothes shall be kept in a suitable place away from all dust and dirt during working hours.

3. Workmen who have to work with lead, lead compounds or lead alloys shall eat plenty of nourishing, and whenever possible, fatty foods, and avoid the use of alcoholic drinks.

4. Food or alcoholic drink shall not be brought into or kept or eaten in the workrooms, neither shall the use of tobacco in any form (cigars, cigarettes, pipes, chewing tobacco or snuff)

be permitted under any conditions in the workrooms or adjacent rooms, except in such places where it is expressly permitted.

5. All food brought in by workmen, or brought to them, shall be kept out of the workrooms and thoroughly protected from dust or dirt, and it shall only be eaten during those intervals, and in such cases where special rooms are set apart for the purpose.

6. After work, and even when work is temporarily interrupted, the hands and face, and especially the beard and moustache and mouth, shall be thoroughly washed and, whenever possible, warm water shall be used for this purpose. The mouth shall also be rinsed out with clean water every time before drinking.

7. Washing, whenever it is possible to avoid it, shall not be done in the workrooms.

8. Workmen shall not keep tobacco, smoking materials, and food in the pockets of their working clothes.

9. Every workman shall take a bath at least once a week, care being taken to thoroughly cleanse hair, beard and moustache.

10. Every workman shall consult a medical man as soon as he shall experience the least indisposition, and shall draw his attention to the fact that he works with lead, lead compounds or lead alloys.

FURTHER NOTICE.

Spitting in the workrooms, except in those receptacles provided for the purpose, shall be strictly prohibited.

Information shall immediately be given to the manager of any accident that may occur.

(4) Decree relating to the protection of workmen employed in printing and lithographing works and type foundries¹

(17th July, 1912)

The Ministry of Commerce, in the course of its endeavours to prevent lead poisoning in smelting works and industrial concerns and in agreement with the Ministry of the Interior, issued on 23rd August, 1911, a decree, on the basis of uniform expressions of opinion received from interested parties, containing special regulations for the protection of the life and health of persons employed in printing and lithographing and also in type foundries, carried on by way of trade.

This decree has been published in Part LXXIV of the Reichsgesetzblatt as No. 169.

In order to respond to the wishes contained in the above-mentioned opinions, which were expressed unanimously by the trade circles concerned, the following is notified to the authorities (Statthalterei), in agreement with the Ministry of the Interior, for its own guidance and for the information of the industrial authorities of first instance and the Chambers of Commerce and Industry.

The decree shall not only apply to industrial printing and lithographing works and type foundries, but, without distinction, also to all industrial concerns in which printing, lithographing and type founding are carried on by way of trade.

In the cases provided for in regulation 1, paragraph 5 (*i.e.*, in the case of the removal of concerns, already existing and approved on the date on which the decree was published, in rented premises), in which exemption from the general provisions with respect to the use of underground rooms may be granted by the provincial authority, the Statthalterei when deciding on each individual case, will have to take into consideration the existing conditions, and carry through with special urgency the necessary official proceedings. The industrial authorities of first instance shall also be instructed in this sense.

The reason for special urgency is that the owner of the undertakings in question can only definitely hire the premises in view if he has the certainty that he will obtain the consent of the industrial authority. As, however, the owner of the house will, as a rule, grant to him only a very short period for making his decision, it will be to the interest of the owner of the undertaking to be in possession of the decision of the authority within the shortest possible time.

For this reason it will be advisable to authorize the subordinate authority, instructed to obtain evidence as a committee, to grant, if possible, the exemption on behalf of the provincial authority in all cases in which the documents sent in with the application justify the assumption that no essential objections exist against the granting of the permission. For this purpose it shall be the duty of the authority of first instance, with whom the application for approval has been lodged, to submit in such cases the records to the provincial authority for decision during the interval between the bringing in of the application and the meeting of the committee. If the documents submitted with the application do not give a clear idea of the matter, the authorities (Statthalterei) shall be authorized, in specially urgent cases, in particular in places where there are situate also the offices of a provincial authority, to send out, already for the first inspection by the committee, expert representatives of the provincial authority duly authorized to give a decision. These representatives may, for instance, consist of the official authorized to deal with the matter in question, and an expert to assist him, and these representatives may

¹ Gilbert Stone, *Laws and Regulations relating to Lead Poisoning*, 1922, pp. 201-207.

in given cases, express directly during the official proceedings of the committee the consent of the provincial authority.

In paragraphs 6 and 8 of regulation 1 a separation of the several localities or departments is demanded, if such is practicable or possible from a technical point of view. Such a practicability or possibility shall be considered as existing if the separation appears to be practicable or possible in view of the position of the building, the conduct of the entire works, or at least the conduct of the departments in question.

As regards bronzing, in particular, attention must be given to the question whether, in a definite case, it is not possible from a technical point of view to effect a separation of the bronzing room from the machine room.

As regards the stipulation of regulation 3 to the effect that the lockers or arrangements placed at the disposal of the workers for keeping their working and outdoor clothes must make it possible to keep the said clothes separate, it may be mentioned that this requirement will be already complied with if, in the bottom part of the lockers in question, a horizontal board is fitted which makes it possible to place the working clothes in the compartment thereby provided in the bottom of the locker. By this means it becomes possible to hang up the outdoor clothes without risk of their being damaged by pressure or of being soiled by lead dust, which might fall on them and would then be carried in the clothes to the private dwellings of the workers.

The decree further distinguishes in several places between work and workers, referred to in regulation 1, paragraph 1, and regulation 1, paragraph 2, respectively. The former include all printing, lithographing, and type foundry work or workers employed in the same in general, and the latter only those kinds of work and the persons employed therein as are enumerated in detail in regulation 1, paragraph 2 (1)-(7).

As regards the confirmation "without charge" of the statements on the conditions of space of the several workrooms required by regulation 14, paragraph 1 (2), it must be observed that the decree starts from the point of view that no unnecessary charge should be laid upon the owner of the undertaking.

In new plants it will be possible to ascertain the facts in question in connection with the proceedings of the committee approving the same. In existing plants, however, with respect to which the decree comes into operation only after the expiration of one year from the date of publication, any expenses by the committee in connection therewith may, as a rule, be avoided, even if the concern in question is not situated at the seat of the industrial authority, by the said approval being given either on the basis of existing plans or on the basis of an inspection on the occasion of any other official proceedings taking place in the said town during the transitory period. As regards finally the official medical examinations (regulation 15), attention is drawn to the fact that these examinations must, as a rule, take place in accordance with regulation 15, outside the working hours of the person to be examined. This rule may be deviated from only should the interest of the official medical service require it, but in every case only with the consent of the manager of the industrial concern in question. If such consent is not given, the examination must be postponed to another day or take place outside the working hours. For carrying out an examination outside the working hours, it is not necessary to obtain the consent of the manager of the concern previously. The said manager must, however, be communicated with, so that, should it be intended to work overtime just at the time fixed for the examination (with a consequent postponement of the hour at which work terminates, after which hour the medical examination may not take place in accordance with regulation 15, paragraph 2), he may, on the one hand, inform the medical officer of the fact and on the other hand, advise the workers in good time that the examination is to take place. The mid-day interval may not be used for such examinations, as it is expressly stated in the decree, "before the commencement or after the termination of the working hours," in which connection there must be understood by working hours the total hours worked per day, which do not terminate, but are only interrupted, by the mid-day interval. In addition to this, the medical officers must have regard, as far as possible, to any wishes which may be expressed with respect to the period of examination.

The printed forms, referred to in paragraph 3 of this section, for entering the medical report, shall be drawn up according to the specimen attached to this decree.

The columns concerning general data shall be filled in on the basis of the wages' list in all cases where such are kept, but otherwise on the basis of the indications of the management of the concern. If there is any indication justifying the assumption that the statements made are not in accordance with the facts, it will be advisable to control in a suitable manner the correctness of the statements made.

Particular importance must be given to the filling-in of all the details in the columns concerning ascertained indications of lead poisoning. Columns 7, 8 and 9 shall be filled in by the sick fund, in the sick or sick-pay lists of which the worker who has shown symptoms of lead poisoning had been entered or on the basis of a communication from such fund. The object of this provision is to establish, with the greatest degree of certainty, whether certain indications, which during the periodical examination appeared to show the existence of lead poisoning, may not be attributed to any other cause, as, for instance, in the case of anæmia, digestive disturbances, trembling, and the like.

For every concern two sheets are intended to be used, the one perforated and the other without perforation. The former, with the exception of columns 7, 8 and 9, must be filled in, in the first instance, by the medical officer, who shall make at the same time a carbon copy; on the back of the second, non-perforated sheet, there is space for any possible remarks by the examining

doctor, as, for instance, for noting down certain instructions given, etc. This sheet shall remain in his possession.

The particulars required for columns 7, 8 and 9 shall be obtained from the sick fund in question, if possible, by sending to such fund the perforated form to be filled in. It will be advisable to send in the forms at regular, but not too short, intervals, perhaps every three months; but the best way of proceeding in this respect will only be found by practice.

The particulars supplied by the sick fund for columns 7, 8, and 9, shall be entered by the medical officer in the copy which he keeps in his possession. The perforated sheets with all the columns duly filled in shall be sent to the provincial authority mentioned on the back of the sheet and be submitted by the latter to the Ministry of Commerce for cognizance to be taken and for further dealing with the same.

If during the inspection of a concern no indications of any lead poisoning were found in any of the workers, the words "negative result" are to be placed above columns 1 to 6 of the lower half of the sheet, and the perforated sheet must be transmitted as a negative report, in the same way as the other copies, to the Ministry of Commerce through the provincial authority.

The provincial authority shall, at the end of the year, submit summarized reports with respect to the results of the examination to the Ministry of the Interior and the Ministry of Commerce.

In all those cases in which the medical officer may find that there are workers in any concern showing indications of lead poisoning, he must communicate the fact immediately also to the competent industrial inspector.

As regards the committee constituted in connection with the medical examinations, it must be mentioned that the matter is not to be considered as one between parties and that consequently no compensation for costs incurred by the committee can be demanded by the owner of the concern as a party. The examinations in places which, by reason of their position, would cause expenses to the committee, shall take place, in order to avoid such expenses, on the occasion of other official acts of the medical officer in the said places, as for instance, on the occasion of his periodical journeys.

As regards the supply of printed matter, the instructions will be issued by the Minister of the Interior.

SCHEDULE.

(First page of cover.)

MEDICAL EXAMINATIONS IN PRINTING AND LITHOGRAPHING WORKS, AS WELL AS IN TYPE FOUNDRIES.

In accordance with Regulation 15 of the Ministerial Decree, dated 23rd August, 1911, R. G. Bl., (No. 169):

(Second page of cover.)

All persons employed on the following work are subject to examination in accordance with Regulation 15 of the Ministerial Decree dated 23rd August, 1911 (R. G. Bl., No. 169):

- (1) The preparation of type metal containing lead (*i.e.*, the melting, smelting, mixing, or melting-down thereof).
- (2) The making of letters and type material from type metal containing lead.
- (3) Stereotyping and backing clichés.
- (4) Work on type-setting machines wherever lead-containing type metal is used.
- (5) All work with lead-containing type metal (*i.e.*, setting and distributing, sorting, dividing, wrapping, etc.)
- (6) All work with dry lead colours.
- (7) Bronzing with bronzing powders and cleansing of bronzing machines and their spare parts.
- (8) Printing work carried out by foreman printers and machine foremen where they have to work with type metal containing lead, or with bronzing powders.

(First page.)

MEDICAL EXAMINATIONS in Printing and Lithographic Works and in Type Foundries (in accordance with Regulation 15 of the Decree dated 23rd August, 1911, R. G. Bl., No. 169):

Country..... Firm (Owner).....
 Political District..... Description of Concern.....
 Commune..... Sick Fund.....
 Date of Examination..... Examining Doctor.....

Perforation.	At the time of the examination there were employed in the concern:	Males			Females			Gross Total
		Above 16 years	Below 16 years	Total	Above 16 years	Below 16 years	Total	
	Total number of workers subject to insurance. ¹							
Of which are employed—	With bronzing work: bronzing by means of bronze powder and cleaning of the respective machinery and accessories.							
	With one of the following kind of type-foundry work: dividing, adjusting, setting, inserting, and similar sorting work, as well as storing and packing work.							

(Continuation of first page.)

Indications of lead poisoning were ascertained in the case of:—

Consecutive Number	Name of worker	Sex	Age	Kind of employment (to be indicated exactly) ¹	Symptoms: anæmia, dark line on gums, radial paralysis, digestive troubles, etc. ²	In consequence of the examination of the: was entered on the sick list ³		What other particulars are known with respect to previous diseases of the nervous system, of the digestive organs, the kidneys, or gout? ³
						from to	with what disease	
1	2	3	4	5	6	7	8	9
.....								
.....								

¹See second page of cover.²To be indicated separately.³Columns 7, 8 and 9 must be filled in by the sick fund or on the basis of a communication from the same; the following particulars must be entered in a given case under column 9: the diagnosis and the period and duration of every such disease. If there are no data available, because the worker did not suffer from any of the diseases enumerated, the words "not ill since . . ." must be entered under column 9. If it is not possible to ascertain definite facts, this must be shown by placing an interrogatory mark under column 9.

(Second page.)

No..... The..... day of.....191..

To the { District Sick Fund
Works Sick Fund
Association Sick Fund
Society Sick Fund
Registered Friendly Society

For the filling in of columns 7, 8, and 9.

District Superintendent's Office.
Magistrate (Magisterial District Office).

No..... The..... day of.....191..

To the District Superintendent's Office.
To the Magistrate (Magisterial District Office)
in.....
Returned after columns 7, 8 and 9 have been filled in.
(Stamp of the Fund.)

No..... The..... day of.....191..

Submitted to the Authorities (Statthalterei).
Provincial Government.
District Superintendent's Office.
Magistrate (Magisterial District Office).

No..... The..... day of.....191..

Submitted to the Ministry of Commerce,
Authorities (Statthalterei).
Provincial Government.

(Third page.)

Same text as page 1.

(Fourth page.)

Space for any possible remarks of the examining doctor.

(25 copies of the pages 1-4 of the Form are always made up in one cover.)

CHAPTER VII

SWITZERLAND

Brief review

There is no federal law governing lead work as such, although there are instructions to lead workers as to means of avoiding lead poisoning, drawn up by the federal inspectors in 1897.

The Federal law on labour in factories of June 18, 1914, touches in a general way on such questions as the Council's authority to prohibit employment of women and children under 16 in industries where there is danger of poisoning; plant cleanliness; removal of deleterious dust and gases; provision of wash basins, lockers and baths; avoidance of dust during plant cleaning, etc.

The Federal law of March 31, 1922, on employment of young people and women in crafts and trades, extends the age of protection of young persons to 18.

As regards *painting*, a decree of the Federal Council of July 30, 1908, directs the services of the federal administration to prohibit the use of white lead in interior painting in buildings built or repaired for the Confederation.

The lead legislation in force in the different cantons relates to painting only, and is as follows:

Canton of St. Gall

Decision of 22. 3. 04, prohibiting use of white lead in painting operations carried out by the State.

Canton of Geneva

Law of 26. 10. 07, on Use of Lead and its Compounds in public and private building works.

Article 1.—The use of white lead, otherwise than in the form of paste, is prohibited for all public or private works, so as to exclude the form of powder whether for painting or for plumbing.

Article 2.—For the same works there is prohibited dry pumice-stoning, dry scraping-off and burning-off of old paint.

Article 3.—An order of the Council of State shall prescribe rules of hygiene, to which masters and workmen shall conform, for the use of products composed of white lead.

Article 4.—Masters and workmen who contravene these present laws or the regulations shall be subject to the criminal law.

Regulations of 21. 12. 07, on the same subject.

Article 1.—The use of white lead, otherwise than in the form of paste, is prohibited for all public and private works, so as to exclude the state of powder, whether for painting or for plumbing.

Article 2.—For the same works there is prohibited dry pumice-stoning, dry scraping-off and burning-off of paint.

Article 3.—There is prohibited the direct use with the hand of products with a basis of white lead for all painting and especially for enduisage (filling-in).

Article 4.—The same workmen shall not be set to pumice-stone freshly painted surfaces continuously. The employer shall see to it that the workman does not perform this work for more than one-half of his day at the most. Apprentices shall never be employed in this kind of work.

Article 5.—It is the duty of employers to provide for their workmen, without charge and in good condition, in all places of work and workshops:

- (a) Apparatus and utensils necessary for avoiding the use of white lead with the hand;
- (b) Overalls or blouses exclusively reserved for painting on buildings, of which employers shall see to the upkeep and frequent washing;
- (c) Places or lockers sufficient to keep free from poisonous dust the clothing which workmen take off during their work;
- (d) The articles and accessories necessary to maintain cleanliness after each interruption of work, especially water, soap, and towels.

Article 6.—It is the duty of workmen to keep constantly in good condition the apparatus and utensils which they receive and never to scrape them down dry. They should, besides this, observe the orders which shall be given to them by their employers as to the use of everything which is handed to them.

Article 7.—Employers must draw the attention of their workmen by means of affixing in the workplaces and pay offices, the text of the law and of the regulations, reproduced in their entirety—to the dangers of poisoning to which carelessness may expose the workmen, and to the rules of hygiene which should be followed to avoid the contact of lead with the skin and absorption of poisonous matter and dust by the respiratory and digestive organs (in particular the danger of smoking and eating during and after work without having first ensured cleanliness—the danger of sweeping up the remains of paint without having first moistened them).

Article 8.—These regulations are applicable to all undertakings and works, public and private, and to all employers for building, whether they are or not already subject to the Federal Law concerning work in factories.

Article 9.—Employers who contravene the law and obligations which are imposed upon them by these regulations, as well as the workmen who contravene the law and Articles 1, 2, 3, and 6, of these regulations, shall be subject to the criminal law.

Canton of Bâle-Ville

Regulations of 27. 6. 14, Article 73, on painting with lead colours.

"The use of colours with a lead base in painting and coating (enduisage) must be avoided so far as possible. The scraping of articles coated with poisonous colours must not be done except in a wet state. Closed places must be provided with ventilation apparatus. All receptacles containing poisonous substances and especially colours with a lead base must have a label clearly showing the nature of their content.

"The employer is bound to put liquid soap, nail brushes, and towels at the disposal of workers using colours. Provision must be made for the installation of wash basins in all wood-yards (chantiers).

"Workers are bound to wash their faces and hands before each meal and before leaving the wood-yards. Working clothes must be taken off before meals.

"Workers are forbidden to eat, drink, smoke, take snuff or chew while they are working with colours with a lead base."

Canton de Bâle-Campagne

Prohibition of colours with a lead base in painting operations on public buildings.

Cantons of Berne, Tessin, Grisons, Turgovie, Appenzel R.E., Argovie and Wie

These have not replied to the questionnaire sent them.

The Other Cantons

Have no specific lead legislation, but most of them have issued hygienic instructions warning workers against occupational dangers.

CHAPTER VIII

BELGIUM

Text of the lead laws.

(1) The Law of August 20, 1909, as to the use of white lead in painting¹

1. The sale, transport and use of white lead are forbidden in the form of powder, small pieces or lumps, when intended for paint work (*travaux de peinture*).

The sale, transport and use of white lead in the form of powder, small pieces, or lumps, intended for other purposes are only permitted under such conditions and such limitations as are fixed by royal decree.

2. White lead intended for paint work shall not be sold, carried or used except in the form of a paste combined with oil.

3. The partial or total prohibition of the sale, transport, and use of other products, when lead is the basis, in the form of powder, small pieces, or lumps, and intended for paint work, can be determined by ministerial decree, after hearing the superior council of public hygiene.

4. Dry rubbing and dry pumicing of surfaces covered with white lead are forbidden.

5. Infringement of the present law and decrees relative to the execution thereof will be punished by a fine of 26-100 francs.

6. In case of repetition of the offence within 12 months after the preceding conviction, the minimum fine shall be raised to 100 francs and the maximum to 1,000 francs.

7. Chapter VII and Article 85 of the first book of the Penal Code shall apply to these infringements.

8. Inspectors of Factories shall have power to prove infringements by prosecution (*faisant foi jusqu'à preuve du contraire*).

A copy of the prosecution report shall be sent within 48 hours to the defendant, otherwise the prosecution falls to the ground.

9. The present law shall come into force a year after the date of the publication.

Given at Laeken,
20 August, 1909.

T.M.L.

(2) The Royal Decree of July 25, 1910, on use of white lead in painting²

Article 1.—In all undertakings of painting in building, the use of white lead as well as the scraping and pumice-stoning of surfaces painted or coated with white lead are subject to the following regulations.

Regulations for Employers and Contractors.

Article 2.—Employers or contractors may only use white lead in the form of paste, ground and mixed with oil.

Article 3.—White lead prepared in this form shall be worked in such a way as to avoid the contact of the surface with the hands and also to avoid splashing. Employers or contractors shall put at the disposal of the workmen the utensils necessary for this purpose.

Article 4.—Employers, contractors or their deputies shall see that the material and tools generally are kept clean.

Article 5.—The work of dry scraping and dry pumice-stoning surfaces painted or coated with white lead is prohibited.

Article 6.—Employers, contractors or their deputies shall see that the workmen engaged in the operations mentioned in Article 1 of the present decree wear clothing and headgear exclusively reserved for the work.

The clothing that the workmen take off before working shall be kept protected from poisonous dust.

Article 7.—Employers or contractors shall place at the disposal of their workmen, both in the workplaces and in the workshops, water and the necessary articles and material for rinsing the mouth, washing with soap the face and hands, and for drying. Employers, contractors or their deputies shall see that their workmen perform these operations before taking food or drink, and before leaving the workshops or the workplaces.

¹ Reports of the Departmental Committees on Danger of Use of Lead, etc., Vol. III, 1920, p. 9.

² *Ibid.*, pp. 9-10.

Food brought into the workshops or carried to the workplaces shall be enclosed in boxes or coverings kept well shut until meal times.

Article 8.—Employers or contractors shall cause workmen employed in the operations mentioned in Article 1 of this decree to be examined quarterly by a doctor approved by the Minister of Industry and Labour.

The expenses of these examinations in accordance with a scale to be prescribed by a Ministerial decree shall be borne by the employers and contractors.

Employers or contractors shall absolutely exclude from all operations which would expose to poisoning workmen attacked by chronic lead poisoning and those who show repeated symptoms of acute poisoning.

They shall exclude temporarily those whose general state of health is bad at the time of the examination.

They shall keep a special register conforming to a model set by the Administration, in which the approved doctor shall enter notes of the observations made by him in the examination. This register shall be delivered to the proper officials upon demand.

Employers or contractors shall not employ workmen given to drunkenness; they shall prohibit the introduction and consumption of spirits in the workshops and workplaces.

Regulations for workmen.

Article 9.—Workmen engaged in the handling of white lead, ground and mixed in paste, shall work in such a way as to avoid the contact of the substance with the hands, as also the producing of splashes.

Article 10.—Workmen are forbidden to dry scrape or dry pumice-stone surfaces painted or coated with white lead.

Article 11.—Workmen engaged upon the operations mentioned in Article 1 of the present decree shall wear clothing and headgear exclusively reserved for the work. They shall keep them in a good state of cleanliness and shall take them off before leaving the workshops or workplaces.

Workmen shall keep the clothing that they take off for working protected from poisonous dust.

Article 12.—Before taking food or drink and before leaving the workshops or workplaces, workmen shall rinse their mouths and also wash their hands and faces with soap.

Food brought into the workshops or carried to the workplaces shall be enclosed in boxes or coverings kept well shut until the meal time.

Article 13.—Workmen shall keep the material and tools under their charge in a good state of cleanliness.

Article 14.—Workmen are forbidden to bring spirits into or consume spirits in the workshops or workplaces.

Article 15.—Workmen are to submit themselves to the medical examinations prescribed in Article 8 of this decree.

General provisions.

Article 16.—Breaches of the prescriptions of this decree shall be punished by a fine of 100 francs.

Article 17.—In case of a repeated offence within 12 months after a conviction under this decree, the minimum fine shall be 100 francs and the maximum 1,000 francs.

Article 18.—Chapter VII and Article 85 of the First Book of the Penal Code shall apply to the offences specified above.

Article 19.—The Inspector of work and those delegated to the inspection of work have the duty of seeing to the execution of this decree.

Offences shall be stated by their reports, which shall be *prima facie* proof.

A copy of the report shall be sent to the offender within 48 hours.

Article 20.—This decree shall replace that of 13th May, 1905, as from 2nd September, 1910.

Article 21.—The Minister of Industry and Labour is charged with the execution of this decree.

(3) Order relating to the manufacture of white lead and other lead compounds¹

(5th November, 1910)

1. The manufacture of white lead, lead oxides (massicot, litharge, minium) and of lead chromates shall be subject to the general conditions and respectively to the special conditions provided by the present regulations.

¹ Gilbert Stone, *Laws and Regulations relating to Lead Poisoning*, 1922, pp. 171-175.

Part I.—Measures imposed upon masters and managers of works.

2. GENERAL CONDITIONS.—(1) All operations shall be effected in roomy, well-ventilated places, which shall be directly and sufficiently illuminated by daylight.

(2) The floors shall be impervious and smooth, and shall be kept in good condition. For each floor stiff supports shall be provided to avoid possible vibrations caused by the working processes.

(3) Every day, after ceasing work, the workshop floors, apparatus and utensils shall be thoroughly cleaned with a hose. At the end of each week, the walls, timberwork, etc., and generally all places where the lead-containing dusts are likely to settle, shall be washed.

All dry cleaning is strictly forbidden.

(4) In the course of all handling of lead compounds the necessary measures shall be taken to avoid contact of the hands with these products, the production of dust, and the dissemination of these materials.

(5) The handles of tools and all objects which are necessarily used by the workmen shall be kept in a perfect state of cleanliness.

(6) The thorough collection of dust in a chamber of sufficient dimensions shall be ensured before the air drawn in by the fans is allowed to escape into the open air.

(7) Before entering the workshop, workmen shall be required to put on a working suit protecting them from plumbiferous dust and splashes. This suit shall preferably be a long narrow blouse fitting closely round the neck and body. This suit shall be washed at least once every week.

(8) A special room separated from the workshops shall serve the purpose of a cloak-room. Each workman shall have at his disposal two pegs, one for his ordinary clothes, the other for his working clothes.

(9) In the same room or in a communicating room lavatory basins shall be provided with fresh running water. The workroom shall be supplied with soap, nail brushes, clayey sand and clean towels.

The installation shall at least include (a) a numbered towel and drinking glass per workman, as well as a lavatory basin for every two workmen; (b) a shower-bath provided with all necessary requirements per five workmen.

(10) Before each meal, either in or outside the works, the workmen shall discard their working clothes, properly wash the hands, face and neck, rinse the mouth, and remove all dust from the hair. They shall further take a tepid shower-bath every evening before leaving the works.

(11) A special room, provided with tables and seats, as well as an apparatus for warming food, shall serve as a dining room.

(12) All sanitary arrangements mentioned above shall be kept very clean, in good condition, well ventilated and heated in winter to a temperature of at least 18 degrees C.

(13) Workmen shall not be allowed to deposit food, or to drink and eat in the works, except in the dining rooms.

(14) Manufacturers shall cause all workmen engaged in the manufacture of lead compounds to be examined monthly by a medical man approved of by the Minister of Industry and Labour.

The charges for the monthly examination, scheduled by Ministerial Order, shall be paid by the manufacturers.

All workmen affected with chronic lead poisoning, and those who show returning symptoms of acute poisoning, shall be definitely kept away from work which would render them liable to poisoning.

All workmen whose general state of health shall be found bad at the time of examination shall be kept temporarily away.

Manufacturers shall keep a special register in accordance with the specimen supplied by the Administration, and in which the appointed doctor shall record the statements made in the course of his monthly examination. This register shall be shown to the officials appointed by the Authorities, whenever requested.

15. Manufacturers shall not employ workmen addicted to drink; they shall forbid the introduction and consumption of spirituous liquors in the factories or yards.

3. SPECIAL REGULATIONS: (A) Relating to the manufacture of White Lead.

- (1) Melting of lead shall take place in a special room, under a hood erected in such a manner as to protect the founder against all fumes. During the running of lead, the hood shall have an opening only sufficient for this operation. Except during the recasting of grids, fins, scrap, etc., it should be possible to close it completely, or to lower it to the mouth of the mould. A machine fan shall

- ensure complete and permanent exhaustion of fumes from beneath the hood during the whole of the time of melting.
- (2) The necessary measures shall be taken for the removal of grids, fins and rubbish without producing dust. If necessary, these grids, fins, or each layer of rubbish shall be sufficiently damped.
 - (3) Picking, cleaning and sifting by hand is prohibited.
 - (4) In the course of all handling of white lead, the necessary precautions shall be taken to prevent any contact of the hand with this material, as well as all splashing of this material.
 - (5) Mechanical cleaning and crushing machines which are not submerged in water shall be enclosed in metal casings which close perfectly and are connected up to suction pipes of high vacuum and arranged so as to prevent the plumbiferous dust from scattering about.
This apparatus shall only be opened after the dust has completely settled; this shall, if necessary, be ensured by a jet of steam or atomized water.
 - (6) From the scraping of grids till the final grinding under water, the white lead shall be conveyed from one apparatus to another by means of mechanical arrangements.
 - (7) Workmen shall not be allowed to enter the drying ovens for the purpose of withdrawing the dry white lead before these have been sufficiently ventilated, and shall have cooled down.
 - (8) The grinding of the cakes of white lead shall be mechanically effected, and the crushing, grinding, and sieving apparatus shall be erected in such a way as to allow the white lead to pass automatically from one apparatus to the other. This apparatus, erected in a special room, shall be provided with metal casings, kept in good condition, so that the smallest amount of white lead may not escape. They shall be provided with mechanical suction fans, and shall not be opened before the complete settlement of the pulverized material.
 - (9) The barrelling of dry white lead shall be mechanically effected by means of arrangements, so that no escape whatever of dust may take place.
 - (10) White lead powder shall be conveyed to the loading hopper of the oil-crushing machine by means of an arrangement thoroughly preventing any production of dust. The hopper shall be covered with a casing, which in turn shall be connected up to a suction pipe. During the whole time of working, the air in the casing shall be drawn off by means of a high-vacuum suction fan.
 - (11) The mixing of the dry white lead with oil, as well as the first transport of the same, shall be effected in hermetically-closed apparatus. From this apparatus the white lead in paste shall be automatically conveyed to the different crushing cylinders.

(B) Relating to the Manufacture of Lead Oxides: Massicot, Litharge, Minium:

- (1) The ovens shall be erected either in the open air or in spacious and well-ventilated positions.
- (2) The necessary precautions shall be taken so that during the operations of mixing and withdrawing from the ovens the workmen shall not be exposed to vapours and dust. Should the ovens not be erected in the open air, suction hoods of high vacuum shall be arranged above the doors.
- (3) When diluting with water, crushing and withdrawing the massicot from the storage vessels, all contact of the lead oxide with the hands shall be avoided, and the necessary precautions taken shall be to prevent splashing.
- (4) The pulverization and sieving shall be effected in hermetically-closed apparatus which shall not be opened until a sufficiently prolonged rest has enabled the dust to settle completely.
- (5) Decanting, barrelling, and heaping-up operations shall be done with all necessary precautions so as to avoid completely the dissemination of dust.

C.—Concerning the Manufacture of Lead Chromate and Colours contained therein.

- (1) In all operations by wet process, the necessary measures shall be taken so that workmen shall be able to avoid touching the material with the hands, and shall be protected from splashes.
- (2) Pulverization, screening, heaping-up, and packing shall be done under such conditions as to prevent any escape whatever of dust. Such operations shall be carried on either under suction hoods of high vacuum or in hermetically-closed apparatus which shall only be opened after a rest sufficiently long to allow the dust to settle completely.

4. Independently of the regulations drawn up as above, the special object of which shall be the prevention of lead poisoning, white-lead manufacturers shall be compelled to adopt the measures indicated below, in order that their business shall not be objectionable to others.

- (1) The rubbish heaps and dustbins shall not be situated close to dwellings of third parties.

The necessary precautions shall be taken to prevent contamination of water in neighbouring wells by liquids containing organic substances from the rubbish heaps.

- (2) No water containing plumbiferous compounds in suspension or solution shall be allowed to soak into the ground or to be discharged outside the building, except into public sewers.
- (3) All combustible matter shall be removed from the drying rooms.

Part II.—Regulations Imposed upon Workmen.

5. Workmen employed in white lead or lead oxide factories, as well as those working in factories manufacturing lead chromate and colours containing this product, shall be compelled to conform strictly to the following Regulations:

- (1) Workmen shall maintain in a perfect state of cleanliness all tool handles and all other articles which they have to handle.
- (2) Before entering the works, workmen shall put on a working suit protecting them from plumbiferous dust and splashes. This suit shall preferably be a long, narrow blouse fitting closely round the neck and body. This suit shall be washed at least once a week.
- (3) Workmen shall only be allowed to keep their clothes in the cloakroom.
- (4) Before each meal taken either on or off the premises, workmen shall take off their working clothes, properly wash the hands, face and neck, rinse the mouth and remove all dust from the hair. They shall, further, take a tepid shower-bath every evening before leaving the works.
- (5) Workmen shall deposit no food, neither shall they eat or drink, in any part of the premises except the dining-room.
- (6) No workmen shall introduce and consume spirits in the works.
- (7) Workmen shall be compelled to submit to the medical examinations provided by regulation 2 (14) of the present Order.

Part III.—General Regulations.

6. Manufacturers shall be compelled to post up the regulations of the present Order in a prominent position in their workshops.

7. Labour inspectors and labour inspectors' deputies shall be responsible to see that the present Order is enforced.

They shall report infringements in reports, which shall be considered reliable unless proved to the contrary.

A copy of the report shall be handed to the offender within forty-eight hours, in default of which it shall be nullified.

8. *Penalties.*—In compliance with the Act dated 5th May, 1888, infringements of the present Order shall be punished by a fine of 26 to 100 francs, without prejudice, if necessary, to the application of the penalties provided by sections 269 to 274 of the Penal Code.

In case of a second offence within twelve months following the sentence incurred by virtue of the Act mentioned above, the minimum fine shall be 100 francs and the maximum 1,000 francs.

9. Book 1 of the Penal Code, without excepting Chapter VII and Section 85, shall be applicable to the infringements mentioned above.

10. The present Order shall replace, from 1st January, 1911, the Royal Orders dated 31st December, 1894, and 18th November, 1902, referring to the manufacture of white lead and other lead compounds.

CHAPTER IX

NETHERLANDS

Text of the lead laws.

(1) Classification of trades¹

Decree of August 21, 1916, S. 418, for withdrawal of the Royal Decree of June 27, 1913 (Staatsblad No. 317), modified by Royal Decree of April 20, 1914 (Staatsblad No. 185) and for fixing a General Rule of Administration as referred to in Articles 6 and 7 of the Safety Law.

Safety Decree, 1916.

We, Wilhelmina, etc.

On the proposal of our Minister of Agriculture, Industry and Trade of the 6th May, 1916, No. 901, Labour Department:

Having regard to Articles 6 and 7 of the Safety Law (made on 20th July, 1895, Staatsblad

No. 137, last amended by that of the 19th June, 1915, Staatsblad No. 281);

Having heard the Council of State (advice of the 11th July, 1916, No. 28);

Having seen the fuller report of our aforesaid Minister of the 18th August, 1916, No. 1703,

Labour Department;

Have thought fit and desirable to lay down the following enactments:

CHAPTER I.—GENERAL PROVISIONS.

Article 1.—The workrooms in factories and workshops shall in this Decree be distinguished into and referred to as

I.—*Injurious, under which, subject to the provisions of IIb, there shall be understood:*

Category A.

Workrooms where, or where as a rule:

1. White lead is prepared;
2. Sugar of lead, oxide of lead (litharge) or red lead is prepared;
3. Lead ash is burnt and reduced;
4. Chromate materials are prepared;
14. Electric accumulators are manufactured or repaired;
15. Zinc is extracted from ores;
16. Enamels are prepared or worked for the manufacture of enamelled articles, if the said enamels contain an amount of lead exceeding half per cent. of their dry weight;

Category B.

Workrooms:

1. Where the air may be contaminated by poisonous dust which spreads during bronzing, for instance in a printing office or a picture-frame workshop;
2. Where as a rule poisonous paint is mixed, worked or used;
4. Where polishing is done with metals containing lead.

Category C.

Workrooms where, as a rule, dusts or vapours spread which, by reason of their properties may have poisonous action such as acrolein, ether, ammonia, amylacetate, aniline and its homologues and derivatives, arseniurated hydride, acetic acid, benzene, benzol and its homologues, methyl bromide, carbol, chloride, creosote, hydro-fluoride, formalin, methylated spirits, carbonic oxide, carbonic acid, quick-silver, naphthalene, nitrous combinations, nitro-benzol and its homologues and derivatives, phosgene, phosphorated hydrogen, picric acid, tetrachlorethane, carbon tetrachloride, zinc oxide, hydrofluoric acid, sulphurous acid, bisulphide of carbon, sulphuretted hydrogen.

¹ Gilbert Stone, Laws and Regulations relating to Lead Poisoning, 1922, pp. 210-212.

Category E.

Workshops where, as a rule, work is done with lead, lead alloys or lead combinations, in:

1. Weight adjusting works;
2. Capsule factories;
3. Printing works;
4. Leaded glass factories;
5. Small shot foundries;
6. Type foundries;
7. Type composing offices, including those in which a composing machine is used;
8. Lead pipe factories;
9. Lead flattening mills;
10. Lead foundries;
11. Metal-ware factories;
12. Musical instrument manufactories;
13. Organ pipe manufactories;
14. Stereotyping plants;
15. File cutting works.

Category F.

Workshops of diamond polishers and cleavers where work is done with lead, lead compounds or lead alloys.

Category L.

Workshops in pottery works, in so far as lead combinations are prepared, applied or worked up in such workshops which contain more than half per cent. of their dry weight in lead, in any other form than sulphide of lead (lead glance, lead ore) or, if articles are handled therein to which such lead combinations are applied.

Category M.

Workshops in which, by the use of an oven, a high temperature is produced, as for instance: bread, biscuit, cake and pastry bakers, varnishing works, pottery, porcelain and tile baking works and enamelling works.

II.—*Non-injurious, under which there shall be understood:*

- (a) All workshops not mentioned under I;
- (b) Workshops and also parts of workshops which are mentioned under I, so long as in respect of same a written and signed declaration applies to the effect that it is to be presumed that there no poisoning, infection or risk, damage or hindrance is occasioned by gases, vapours or dust by the processes of work. This declaration will be made by or on behalf of our Minister entrusted with the execution of this Order.

(2) Decree: Employment of women and young persons¹

(Dated 10th August, 1920)

Extracts relating to lead.

CHAPTER II.—PROHIBITION OF EMPLOYMENT OF YOUNG PERSONS AND WOMEN IN FACTORIES AND WORKPLACES.

Division 2.—Factories and workshops in which particular operations are carried on or particular substances or conditions are present.

Section 34.—A young person or a woman shall not be employed in a factory or workshop in certain specified cases.

The specified cases include the following *lead* processes:

- (a) The preparation of white lead.
- (b) The preparation of sugar of lead, lead oxide (massicot, litharge), or red lead.
- (c) The preparation of chromates.
- (d) The further manipulation of the above in order to prepare them for delivery or use.
- (e) The manufacture or repair of electric accumulators.
- (f) The preparation or treatment of enamels for the manufacture of enamelled goods, if the enamel contains lead to the extent of more than one-half of its weight in a dry state.

Section 35.—(1) A young person shall not be employed in a factory or workshop in certain specified cases unless the provisions of subsections (3)-(10) below are observed.

(3) A valid declaration respecting each young person (or woman) shall be available, showing that the work gives rise to no special danger to his or her health or life.

¹International Labour Office, Geneva, L.S. 1920. Neth. 8.

(4) The declaration referred to in the foregoing subsection shall be given by a medical officer of the labour inspection service or a medical practitioner designated by the chief of the district, after he has examined the young person or woman.

(5) The declaration shall be drawn up and signed by the medical practitioner who has made the examination. It shall state the length of the period for which it is valid, which shall not be fixed at more than two years.

(6) The declaration shall be made in the form prescribed by Our Minister. Different forms may be prescribed in the case of different kinds of work, or work under different conditions, and for different groups of persons.

(7) The medical declarations shall be properly preserved and shall be produced immediately for inspection on the request of any of the officials specified in Section 84, sub-section (1), of The Labour Act, 1919.

(8) No marks shall be made on the declaration, and notes made thereon by the examining medical practitioner or any official of the Labour inspection service shall not be rendered illegible.

(9) On the termination of the contract of service between the head or manager of the undertaking and the person in respect of whom he holds a medical declaration, the declaration shall, without delay, be handed to the person in question on the first request, or placed at his or her disposal.

(10) If the chief of the district so requires, a room shall be made available for the medical examination which is suitable, heated if necessary, and in his opinion fit for the purpose.

The special cases include the following lead processes:

- (a) Where as a rule poisonous colours are mixed, treated, or used.
- (b) Where polishing is done with powder containing lead; in each case so far as in the opinion of the chief of the district there is serious danger of an injurious influence on health from the poisonous substances in places where work is carried on.
- (c) Work in workrooms where lead, lead alloys, or lead compounds are as a rule used in:
 - (1) the adjusting of weights;
 - (2) capsule factories;
 - (3) printing works;
 - (4) lead glass works;
 - (5) shot foundries;
 - (6) type foundries;
 - (7) type-setting works, including works where type-setting machines are used;
 - (8) lead pipe works;
 - (9) lead rolling works;
 - (10) lead smelting works;
 - (11) metal goods factories;
 - (12) musical instrument factories;
 - (13) organ pipe factories;
 - (14) stereotyping establishments;
 - (15) file-cutting works;

unless the chief of the district has given a written declaration that in his opinion the work in the said workplace gives rise to no danger of lead poisoning.

- (d) Work in workrooms in diamond cutting and polishing works where lead, lead compounds or lead alloys are as a rule used in the work.

35. (2) A woman shall not be employed in a factory or workplace in certain specified cases unless the same provisions as above, subsections (3)-(10) are observed.

The specified cases include the following lead processes:

- (a) Where as a rule poisonous colours are mixed, treated, or used.
- (b) Where polishing is done with powder containing lead; in each case so far as in the opinion of the chief of the district there is serious danger of an injurious influence on health from the poisonous substances in places where work is carried on.
- (c) Work in workrooms where lead, lead alloys or lead compounds are as a rule used in
 - printing works,
 - type foundries,
 - type-setting works, including works where type-setting machines are used.
 - stereotyping establishments.

Section 37.—(1) A young person or a woman shall not be employed in a factory or workplace in any work

- (a) where as a rule poisonous colours are mixed, treated or used, or
- (b) where polishing is done with powder containing lead; in each case so far as in the opinion of the chief of the district there is serious danger of an injurious influence on health from the poisonous substances in places where work is carried on, unless the workroom in which the young person or woman is employed contains a free air space for each worker of not less than 10 cubic metres, of which not less than 4 cubic metres shall be above a height of 1.8 metres.

If the workroom was in use as such before 1st October, 1920, the parts of which the height is less than 2 metres shall not be included in the calculation of the free air space either of the workroom as a whole or of the part thereof above 1.8 metres, for the purpose of the application of this provision. In all other cases parts of which the height is less than 2.5 metres shall not be included.

Section 38.—The following rules shall govern the application of the provisions of Section 37:

- (a) In the calculation of the free air space either of a workroom as a whole or of the part thereof above the height of 1.8 metres, parts above a height of 5 metres shall not be included.
- (b) Rooms which are directly connected with the workroom, in such a manner that communication cannot be shut off, shall be deemed to form part of the said workroom if the opening by which communication takes place has an area of not less than 1.8 square metres.
- (c) Without prejudice to the provisions under (b), not more persons shall be present in a workroom which is deemed to constitute a single whole with one or more other rooms, than $1\frac{1}{2}$ times the number of persons who might be present there if communication did not exist, provided that not more persons shall remain in the rooms altogether than might remain there if communication did not exist.

Section 39.—A young person or a woman shall not be employed in a factory or workplace in (a) work where as a rule poisonous colours are mixed, treated or used, or (b) where polishing is done with powder containing lead; in each case so far as in the opinion of the chief of the district there is serious danger of an injurious influence on health from the poisonous substances in places where work is carried on, unless the following provisions are observed:

(1) Adequate precautions against the danger of poisoning shall be taken in conformity with the requirements of the chief of the district:

(2) An overall, and if necessary a head covering, for compulsory wear at work during the week, shall be supplied to each young person or woman on the first working day of each week, marked and properly washed and dried, exclusively for his or her use.

If the chief of the district has issued requirements:

- (a) Concerning the supply of a clean overall or head covering on other days than the first working day of the week;
- (b) respecting the pattern and mode of marking of the overalls and head coverings;
- (c) in respect of the supply and wearing of head coverings, the said requirements shall be complied with.

(3) A suitable place, fitted up in accordance with the instructions issued by the chief of the district, shall be available for depositing the clothing which the young person or woman must remove before beginning work.

(4) Food shall not be kept in the workroom by or for the young person or woman, and food shall not be consumed or meal times spent there, unless the chief of the district has expressed the opinion that this gives rise to no special danger to life or health.

If the chief of the district so requires, satisfactory arrangements for meals shall be provided for the young person or woman.

(5) Suitably installed washing conveniences, situated indoors, shall be available in the factory or workplaces. Soap and a sufficient number of towels shall be available with each washing convenience, and arrangements shall be made for drawing off the waste water and applying a sufficient quantity of clean water.

If the chief of the district so requires:

- (a) the number of nail brushes specified by him shall be provided with each washing convenience;
- (b) the specified number of towels shall be supplied in such manner and at such times as are specified by him;
- (c) an adequate supply of warm water shall be provided in the washing conveniences.

The washing conveniences shall in all other respects be installed in accordance with the instructions of the chief of the district.

Sufficient time shall be allowed to the persons in question, at the end of each period of work, for making use of a washing convenience.

(6) The floor of the workroom shall be suitably constructed and so arranged that it can be kept clean.

(7) The floor of the workroom shall be scrubbed or swabbed at least once a week.

(8) The walls and ceiling of the workroom shall be properly whitewashed, washed down, or otherwise cleaned at least once every 15 months. If the chief of the district so requires, the whitewashing, washing down or cleaning shall take place at the intervals and in the manner prescribed by him.

**Section 42.*—A young person or a woman shall not be employed in a factory or workshop in certain specified cases unless the following provisions are observed:

**The reference text here (International Labour Office, Geneva, L. S. 1920, Neth. 8, p. 23) refers to a different class of specified cases (that is Class C, not E), but is here amended in accordance with what is thought to be the correct form.—R.M.H.*

(1) An overall, and if necessary a head covering, for compulsory wear at work during the week, shall be supplied to each young person or woman on the first working day of each week, marked and properly washed and dried, exclusively for his or her use.

If the chief of the district has issued requirements:

- (a) concerning the supply of a clean overall or head covering on other days than the first working day of the week;
- (b) respecting the pattern and mode of marking of the overalls and head coverings;
- (c) in respect of the supply and wearing of head coverings; these requirements also shall be complied with.

(2) Food shall not be kept in the workroom by or for the young person or woman, and food shall not be consumed or meal times spent there, unless the chief of the district has expressed the opinion that this gives rise to no danger to life or health.

If the chief of the district so requires, satisfactory arrangements for meals shall be provided for the young person or woman.

(3) Suitably installed washing conveniences, situated indoors, shall be available in the factory or workplace. Soap and a sufficient number of towels shall be available in each washing convenience, and arrangements shall be made for drawing off waste water and supplying a sufficient quantity of clean water.

If the chief of the district so requires:

- (a) the number of nail brushes specified by him shall be provided with each washing convenience;
- (b) the specified number of towels shall be supplied in the manner and at the times prescribed by him.

The washing conveniences shall in all other respects be installed in accordance with the instructions of the chief of the district.

Sufficient time shall be allowed to the persons in question, at the end of each period of work, for making use of a washing convenience.

(4) The floor of the workroom shall be suitably constructed and so arranged that it can be kept clean.

(5) The floor of the workroom shall be scrubbed or swabbed at least once a week, unless it is treated with dust-absorbing oil in a manner regarded by the chief of the district as adequate, or unless there are no cracks in the floor.

(6) The walls and ceiling of the workroom shall be properly whitewashed, washed down or otherwise cleaned at least once every 15 months. If the chief of the district so requires, the whitewashing, washing down or cleaning shall take place at the intervals and in the manner prescribed by him.

The specified cases include the following lead processes:

Work in workrooms where lead, lead alloys or lead compounds are as a rule used in:

- (1) the adjusting of weights;
- (2) capsule factories;
- (3) printing works;
- (4) lead glass works;
- (5) shot foundries;
- (6) type foundries;
- (7) type-setting works, including works where type-setting machines are used;
- (8) lead pipe works;
- (9) lead rolling works;
- (10) lead smelting works;
- (11) metal goods factories;
- (12) musical instrument factories;
- (13) organ pipe factories;
- (14) stereotyping establishments;
- (15) file-cutting works;

unless the chief of the district has given a written declaration that in his opinion the work in the said fireplace gives rise to no danger of lead poisoning.

Section 43.—A young person or a woman shall not be employed in diamond cutting and polishing works where lead, lead compounds, or lead alloys are as a rule used in the work unless the following provisions are observed:

(1) Lead makeweights shall be adequately covered.

(2) Food shall not be kept in the workroom by or for the young person or woman, and food shall not be consumed or meal times spent there, unless the chief of the district has expressed the opinion that this gives rise to no special danger to life or health.

If the chief of the district so requires, satisfactory arrangements for meals shall be provided for the young person or woman.

(3) Suitably installed washing conveniences, situated indoors, shall be available in the factory or workplace.

Soap and a sufficient number of towels shall be made available in each washing convenience, and arrangements shall be made for drawing off waste water and supplying a sufficient quantity of clean water.

If the chief of the district so requires:

- (a) the number of nail brushes specified by him shall be provided with each washing convenience;
- (b) the specified number of towels shall be supplied in the manner and at the times prescribed by him.

The washing conveniences shall in all other respects be installed in accordance with the instructions of the chief of the district.

Sufficient time shall be allowed to the persons in question, at the end of each period of work, for making use of a washing convenience.

(4) The floor of the workroom shall be suitably constructed, and so arranged that it can be kept clean.

(5) The floor of the workroom shall be scrubbed or swabbed at least once a week.

(6) The walls and ceiling of the workroom shall be properly whitewashed, washed down or otherwise cleaned at least once every fifteen months.

If the chief of the district so requires, the white-washing, washing down or cleaning shall take place at the intervals and in the manner prescribed by him.

Division IV.—Factories and workplaces in which ceramic industries are carried on.

50. The provisions of this Division shall apply to work performed in factories and work-places where ceramic industries are carried on, in so far as lead compounds are prepared, used or treated in this work which contain more lead than one-half per cent. of their weight in a dry condition in any other form than sulphide of lead (galena, lead ore) or in so far as objects are handled therein to which such lead compounds are applied.

This work shall be divided into Classes I, II, III, IV, V, VI, VII, VIII.

Class I shall comprise work in rooms where, or where as a rule, the preparation of the glaze takes place, including grinding, sifting, mixing and vitrification.

Class II shall comprise glazing (dipping into the glaze-tub or applying the glaze otherwise, e.g., by spraying).

Class III shall comprise work other than that belonging to the foregoing class, which is performed in connection with the application of glaze to articles, namely:

- (1) putting up (the regular handing of articles to the dipper);
- (2) taking off (the receiving of dipped articles);
- (3) touching up the coat of glaze or removing superfluous glaze in so far as this is not done in glost placing;
- (4) carrying away (taking dipped articles to the glost placing shop);
- (5) washing boards and cleaning tubs;
- (6) taking saggars with dipped or glost articles to the oven.

Class IV shall comprise work which is performed in connection with glost placing (placing dipped articles in saggars), or, when saggars are not used, which consists in placing the dipped articles in the ovens.

Class V shall comprise work consisting in the preparation, grinding and mixing of ceramic colours.

Class VI shall comprise work consisting in:

- (1) the decoration of glazed articles;
- (2) the application of ceramic colours to articles by dry spraying or dusting, when either is done in a manner which is considered dangerous by the chief of the district in consultation with a medical officer of the labour inspection service.

Class VII shall comprise work consisting in:

- (1) the application of ceramic colours to biscuit or glost ware by printing or painting;
- (2) the decoration of dipped articles or the application of ceramic colours to articles by dry spraying or dusting, when either is done in a manner which is considered dangerous by the chief of the district in consultation with a medical officer of the labour inspection service.

Class VIII shall comprise work not mentioned in the foregoing classes, which is carried on in rooms where work belonging to one or more of the foregoing classes is done, and in circumstances in which there is danger of poisoning in the opinion of the chief of the district, in consultation with a medical officer of the labour inspection service.

In this Division there shall be understood:

by *biscuit*, the baked ware not covered with glaze;

by *glaze*, the substance which produces a vitreous coating on the ware when heated;

by *glost ware*, the ware on which the glaze has been transformed into a vitreous coating by heating.

51. A person below 16 years of age or a woman of 16 years of age and upwards shall not be employed in work belonging to any of the Classes I, II, V, or VI, of Section 50.

52. A person below 16 years of age, or a married woman, shall not be employed in work belonging to Class III of Section 50.

An unmarried woman of 16 years and upwards shall not be employed in the said work unless the following provisions are observed in respect of her:

- (1) the glaze to be used shall contain no lead compounds which have not been vitrified by fusion;
- (2) the glaze to be used, when treated with an aqueous solution of hydrochloric acid containing 0.25 per cent. of the acid in accordance with the method prescribed below, shall not yield more than $2\frac{1}{2}$ per cent. of monoxide of lead in solution.

The prescribed method is as follows:

One part by weight (if possible one gram) of the substance, dried at 100 degrees Celsius to a constant weight, is shaken for one hour with 1,000 parts by weight of an aqueous solution of hydrochloric acid containing 0.25 per cent. of the acid. The mixture is then allowed to settle for one hour, after which the liquid, which is settled as much as possible, is syphoned off and completely clarified by filtration. In a known part of the clear filtrate, which must, however, contain not less than three-quarters of the original quantity of liquid, the lead is precipitated as lead sulphide by means of sulphuretted hydrogen. The lead sulphide is next dissolved by heating with dilute nitric acid (Sp. Gr. 1.2). After removing the excess of nitric acid by evaporation over a water bath, the lead is precipitated as lead sulphate by means of an excess of dilute sulphuric acid with the addition of double the volume of alcohol. If, in addition to the lead sulphate, other salts precipitable by alcohol are present in the solution, no alcohol is added. After at least 12 hours the lead sulphate is separated by filtration, and if precipitated with alcohol it is washed with this liquid, or if no alcohol was added for precipitation, it is washed first with dilute sulphuric acid and afterwards with alcohol. The weight of the precipitate is next ascertained, after heating it to a dull red heat and cooling it in the desiccator. Finally the weight of monoxide of lead is calculated from the ascertained weight of lead sulphate.

- (3) An overall, and if necessary a head covering, for compulsory wear at work during the week, shall be supplied to each woman on the first working day of each week, marked and properly washed and dried, exclusively for her use.

If the chief of the district has issued requirements:

- (a) concerning the supply of a clean overall or head covering on other days than the first working day of the week;
 - (b) respecting the pattern and mode of marking of the overalls and head coverings;
 - (c) in respect of the supply and wearing of head coverings;
- these requirements shall be complied with.
- (4) A suitable place shall be available for depositing the clothing which the women must remove before beginning work, fitted up in accordance with the instruction of the chief of the district.
 - (5) Suitably installed washing conveniences, situated indoors, shall be available in the factory or workplace. Soap and a sufficient number of towels shall be available with each washing convenience, and arrangements shall be made for drawing off waste water and supplying a sufficient quantity of clean water.

If the chief of the district so requires:

- (a) the number of nail brushes specified by him shall be provided with each washing convenience;
 - (b) the specified number of towels shall be supplied in the manner and at the times prescribed by him;
 - (c) warm water in sufficient quantity shall be supplied in the washing conveniences.
- The washing conveniences shall in all other respects be installed in accordance with the instructions of the chief of the district.

Sufficient time shall be allowed to the persons in question, at the end of each period of work, to make use of a washing convenience.

- (6) The workroom shall contain a free air space of not less than 10 cubic metres for every person present therein, in the calculation of which only parts of the workroom shall be included, of which the height is 3 metres or more, except in so far as the said parts are above a height of 5 metres.
- (7) A dated declaration shall be available in the factory or workplace in respect of each worker, showing that her physical condition is not such that the work gives rise to any special danger for her.

This declaration shall be made after examination by a medical officer of the labour inspection service or by any other medical practitioner designated by Our Minister, and shall be entered in a register of the form prescribed by Our Minister and kept in the manner prescribed by him.

The declaration shall be not more than three months old; it may at any time be withdrawn by the medical practitioner designated under the foregoing paragraph.

The register shall be immediately produced for inspection on the request of any of the officials mentioned in Section 84, Sub-section (1) of the Labour Act, 1919.

A room shall be available for the medical examination, which in the opinion of the medical practitioner charged with the examination is suitable for the purpose.

- (8) Food shall not be consumed by the woman in the factory or workplace, or meal times spent there, except in a mess room fitted up in accordance with the requirements of the chief of the district.

53. A person below 16 years of age shall not be employed in work belonging to Class IV of Section 50.

A woman of 16 years and upwards shall not be employed in the said work unless the provisions of the foregoing section under Nos. (1)-(8) are observed in respect of her.

54. A person below 16 years of age, or a woman of 16 years and upwards, shall not be employed in any work belonging to Class VII of Section 50, unless the provisions of Section 52, Sub-section (5), are observed in respect of him or her.

55. A person below 16 years of age, or a woman of 16 years and upwards, shall not be employed in any work belonging to Class VIII of Section 50 unless the provisions of Section 52, Sub-section (3), (4), (5), (7) and (8) are observed in respect of him or her, in so far as the observance of the said provisions is considered necessary by the chief of the district.

CHAPTER X

RUSSIA

Text of the lead laws

(1) Regulations relative to copper, silver lead, and lead works¹

(Dated 17th-30th May, 1909)

1. Before being engaged to work in copper, silver lead or lead-smelting works, every workman shall be examined by a medical practitioner.

2. (1) Persons of the female sex and (2) persons of the male sex in a weak state of health or under fifteen years of age shall not be employed in roasting ore, in subjecting raw metal to Bessemer's process, or in cupelling or amalgamation work.

3. The management of the smelting works shall appoint a medical practitioner to supervise the health of the workmen. The said medical practitioner shall examine such persons at least once every month. Workmen showing symptoms of any disease of occupation shall, if the medical practitioner so requires, be suspended from their work even if their condition is not such as to render them unable to continue the work in question and they shall not be permitted to return to work until they shall have been completely cured. The medical practitioner shall at his discretion decide in such cases whether a workman shall be suspended from working in the smelting works altogether, or whether he may be transferred to some other which is not injurious to his health.

4. The management of the smelting works shall keep on record cards or in a bound book a register of medical examinations. On these cards or in the book there shall be entered (a) the name of the medical practitioner entrusted with the supervision of the workmen's health; (b) the name, family name, age and residence of every workman, the date of his entering and leaving the employment and the nature of his occupation; (c) the result of the medical examination of the workman on his entering the employment; (d) the date on which the workman's disease was first observed and the nature of the disease; (e) the date of his recovery, if this is known to the management of the smelting works; and (f) the dates and results of the medical examination.

The pages of the bound books and the record cards shall be numbered consecutively and the district mining engineer having authority shall place on them the necessary stamp or seal.

5. An ample supply of drinking water shall be provided near the workplaces. This drinking water shall be kept free from all impurities, and shall be available in a room which the workmen can enter without going out of doors.

6. In all works there shall be provided for the use of the workmen lavatories and cloakrooms and a separate messroom. These rooms must be provided in a part of the works into which no dust arising from the work penetrates and shall be maintained in a clean state, and heated in the cold season.

Water, soap and towels shall be provided in the lavatories and cloakrooms. In addition, a special place shall be provided in these rooms in which workmen may put clothing removed before beginning work.

The management of the smelting works shall provide a bath in the works, and shall give the workmen an opportunity of using the same at least twice a week. In exceptional cases, the use of the bath shall, if the medical practitioner so requires, also be allowed during hours of work.

7. It shall be the duty of the management of the smelting works to see that the workmen observe the following regulations: (a) they shall not take meals except in the rooms provided for the purpose, and must not take food into the workrooms; and (b) they shall not enter the messroom, commence eating or leave the works until they have first carefully washed their hands and faces.

8. The present regulations shall be affixed in a conspicuous place in every workroom, and in the messroom and cloakrooms and shall be printed in the employment books to be given to the workmen.

(2) Regulations relative to the manufacture of lead preparations²

(19th February to 3rd March, 1913. Confirmed 31st March to 13th April, 1913)

1. The provisions referred to in regulations 2 to 25 of these regulations shall apply to all factories and workshops in which the manufacture of lead preparations, such as white-lead, acetate of lead, red lead, etc., is carried on.

These regulations shall not apply to lead-smelting works.

¹ Gilbert Stone, *Laws and Regulations relating to Lead Poisoning*, 1922, pp. 221-222.

² *Ibid.*, pp. 222-225.

2. The ceilings, walls and floors of the factory premises shall be maintained in a thoroughly clean condition. The floors and walls shall be so constructed that they can be easily washed; if this condition cannot be complied with, they shall, as often as possible, be cleansed from all dust and be whitewashed at least twice a year (in spring and autumn). The floors shall be even and impervious to water, and shall be cleaned daily, and, if not already permanently maintained in a damp state for the purposes of the work, they shall be cleaned by a wet method.

3. The opening of the furnace shall be provided with hoods, having ventilation pipes for drawing off the dust when the furnaces are emptied. The premises in which the lead is smelted and the lead plates are cast, shall be provided with suitable artificial ventilation.

4. The litharge shall be carried from the oxidizing room into the straining chamber in closed receptacles, out of which it shall be poured directly into the sieve or emptied into a separate box, impervious to the contents and hermetically closed, by means of special openings provided in the sides of the box which can be shut by means of flaps; the litharge shall be conveyed automatically from the box to the sieve, either through an automatic discharge or by means of a mechanical device.

5. The newly sifted litharge, as well as the dry cast lead, shall be conveyed directly to closed receptacles, out of which they shall be taken, as and when required, into the room in which the white lead is manufactured.

6. The chambers used in the process of the manufacture of white lead, the Jaroslaw white lead chambers, and the lathes, at the time when the sheets of lead are hung up, shall be kept in a moist condition. After termination of the process of manufacture of white lead, and before the workers are permitted to enter the chambers, the latter must be sufficiently cooled and aired, and also sufficiently moistened to prevent the spread of lead dust during the emptying process. The same regulations shall apply to the Jaroslaw white lead chambers. Thermometers shall be placed in these rooms.

7. The removal of the white lead from the lathes, the mixing of the litharge and of the lead with the acetate for the manufacture of white lead, the rubbing of the white lead through a sieve, as well as the smoothing out of the damp mass in the moulds shall, in no circumstances, be carried out directly by hand.

8. The dried white lead shall be poured into closed receptacles, impervious to the contents, and taken in these to the mill, where it shall be automatically conveyed into the grinding apparatus.

9. The sifting apparatus for the litharge and the apparatus for the grinding of the white lead shall be placed in jackets impervious to the contents and provided with ventilation piping. When the apparatus is not automatically started, the crank-handle, by means of which it is set in motion, shall be led through the wall into an adjoining room; this last requirement shall not apply to portable apparatus.

10. The packing of lead preparations, either in the shape of powder or in pieces, shall, as far as possible, be automatically carried out in rooms separated from the remaining workshops and provided with sufficient ventilation.

11. The conveyance, the transfer, and the storing of all manufactured products (both the final and the intermediate products) shall be carried out in such a manner as not to produce any dust.

12. Workers who have not yet attained 15 years of age shall not be employed on work in the factories and workshops enumerated in regulation 1 of these regulations. Female workers and minors between the ages of 15 and 17 shall only be allowed to be employed on work in which they are not exposed to the action of lead dust, lead gases, and lead fumes, and do not come in contact with substances containing lead.

13. Every worker shall be medically examined before being engaged for any of the work mentioned in regulation 1 of these regulations.

14. A medical man shall constantly supervise the state of health of the workers. The workers shall be medically examined at least twice during every month. Workers who show symptoms of any disease connected with their particular occupation shall, at the request of the medical man, be suspended from their occupation, even if their condition would not prevent them from continuing their work, and shall not be allowed to resume work until they have entirely recovered. In this connection, it shall rest with the medical man to decide whether such workers shall be entirely removed from work in the factory or be transferred to other occupations not injurious to their health.

15. The works' management shall be compelled to keep a record of medical examinations, either on registration slips or in a bound book. The following information shall be entered on the above-mentioned slips or in the book: (a) The name of the medical man entrusted with the supervision of the health of the workers; (b) the name, family, age and place of residence of each worker, the date on which he entered upon and on which he left his employment, the nature of his occupation; (c) the dates of the medical examination of the workers on their engagement; (d) the date on which the sickness was ascertained, and the nature of the illness; (e) the date of recovery, when it is known to the works' management; and (f) the dates and the results of the medical examinations.

16. The duration of the working-time, after deducting the periods of rest, shall not exceed, within the twenty-four hours: (1) Five hours for workers employed in the Jaroslaw white lead chambers; (2) eight hours for workers occupied in charging and emptying the chambers, and

with the straining, casting and grinding of the white lead; (3) 10 hours for other workers who come in contact with lead and substances containing lead.

17. The works' management shall be compelled to supply free of charge to all workers, during working hours, overalls, trousers, and head-coverings, and to the workers engaged in the emptying of the chambers in which the white lead is manufactured, foot-coverings also. All these articles (with the exception of the foot-coverings) shall be changed and washed at least once a week at the expense of the works' management.

18. Workers shall only be admitted to occupations, during the process of which lead dust is given off, on condition that their noses and mouths are covered by the respirators supplied to them by the works' management. These respirators shall be washed and disinfected daily after the termination of the work, and shall be stored in special locked rooms.

19. Where sifting is carried on, it shall be effected by means of brushes, which shall be supplied in sufficient numbers by the works' management.

20. Lavatories and dressing-rooms for the workers shall be provided in the factories. These premises shall be situated in a part of the factory where no factory dust can penetrate, preferably in an adjoining building; they shall be maintained in a clean condition, heated and so arranged that the workers, after they have washed, shall not again have to pass through workrooms and through rooms in which working clothes are stored. In the lavatories (in accordance with the requirements of the medical man) hot water shall be provided for rinsing the mouth and washing the hands, also soap, a sufficient number of towels and brushes, for cleaning the nails, as well as a lotion. The towels shall be changed and washed at least twice a week at the expense of the works' management. Persons specially appointed by the works' management shall be in charge of the lavatories and their accessories, and shall supervise as regards cleanliness and order. Two locked chests, separated from each other, shall be provided in the dressing-room, one to receive the articles enumerated in regulation 17, and the other to receive the ordinary articles of clothing taken off by the workers before beginning their work.

21. Good drinking water shall be supplied to the workers; it shall be kept in hermetically sealed receptacles into which no dust can penetrate.

22. The works' management shall be compelled to allow all workers to make use of the baths free of charge at least once a week, and more often if desired.

23. Preventive medicine shall only be given on the medical man's prescription.

24. The works' management shall see that the workers observe the following regulations:

- (a) They shall eat no food in any workrooms, nor shall they smoke or introduce any kind of food into such premises.
- (b) They shall put on, before commencing work, the articles of clothing provided for them by the works' management, and, when their occupation requires it, make use of the respirators;
- (c) They shall not enter into the messrooms, begin any meal, or leave the factory, without having previously changed their clothing, removed all factory dust from their foot-covering by a moist method and carefully washed hands and face.

25. These regulations shall be posted up in a prominent position in all workrooms, mess-rooms, and dressing-rooms, and shall also be entered in the wages books to be handed to the workers.

CHAPTER XI

GREECE

Regulations with respect to sanitary conditions in printing works¹

(11th-24th February, 1914.)

1. In addition to the general provisions contained in the Royal Decree, dated 25th April-8th May, 1913, "hygienic conditions and the safety of workers in factories, etc.," the special provisions of the following sections shall be adhered to in printing works; if, when applying these special provisions it should be found that they are in contradiction with the general provisions of the Royal Decree dated 25th April-8th May, 1913, the former should be given the preference.

2. The height of the composing rooms shall be at least 3 m.; air space of at least 10 cub.m. shall be provided for every worker. Rooms in which work is carried on by means of linotype machines shall have a height of at least 3 m., and in these rooms air space of at least 20 cub. m. shall be provided for every worker.

The cubic contents of the workrooms shall be stated on a notice, which shall bear the signature of the employer and be exhibited in the workroom, in a place where it can be easily seen by the staff.

In cases of temporary or extraordinary requirements, permission may be obtained from the competent Prefecture, upon application made by the employer, to employ in the workrooms a larger number of workers than that corresponding to the cubic contents of such rooms, but only for periods not exceeding 14 days in every year; the average air space per person shall never be below 8 cub.m.

3. The floor of the several rooms of the building shall be covered with a dry and waterproof material without joints, so that the creation of dust and accumulation of dirt may be prevented and that the rooms may be cleaned without difficulty.

In printing works in which less than eight workers are employed the floor may be of wood; in such a case, however, the floor shall be saturated with boiled linseed oil or receive a coating of oil colour. The joints of the floor shall be caulked.

4. The walls and ceilings shall be distempered with a light water colour, unless they are coated with a waterproof and smooth material, which can be washed at regular intervals. Distempering shall be renewed once in every year.

5. All parts of the letter cases and the remaining furniture shall be fixed to the floor in such a manner that no dust can accumulate under the same or shall rest on supports so that there remains a sufficiently high intermediate space between the supports and the floor for sweeping and washing the latter without difficulty.

6. The floor shall be swept daily with a wet broom, at a time when no work is being carried on; as far as possible, the floor shall also be washed. The letter cases, furniture, windows, and all other articles shall be dusted with a wet cloth; for removing the dust, a dust suction apparatus may also be used. In this operation the raising of dust shall be avoided.

7. If the letter cases are dusted in the open air, bellows may be used for the purpose. For dusting the letter cases in the workroom itself, a special dust suction apparatus shall be used.

8. Printing works shall not be installed in underground premises the floor of which is more than 1.50 m. below the level of the street.

It shall be permissible to erect printing machines in underground rooms, if the latter are airy, light and dry (see section 7 (3) of the Royal Decree dated 25th April-8th May, 1913), with respect to the administration of the Act respecting hygienic conditions and safety of workers in factories.

9. The washing of type and printing plates on the floor of the printing works is prohibited. For this purpose a large trough shall be used. After the washing, the water shall be poured into a covered pit or drain.

10. In winter the renewal of air in the workrooms shall be effected by a sufficient number of air pipes to be fitted above the windows. In summer the windows shall remain open as far as possible. The hours of opening shall coincide with the hours of rest.

During every midday interval and every evening the air shall be completely renewed by doors and windows being kept open.

11. Clothing taken off during working hours shall be kept in a special room.

The workers shall be bound to provide for themselves, at their own expense, a blouse with narrow sleeves, closed at the neck. This blouse shall be worn during working hours.

12. The employers shall be bound to see that washing basins, with a sufficient quantity of water and soap, are at the disposal of the workers.

One washing basin shall be provided for every 15 workers.

Every worker shall provide himself, at his own expense, with a clean towel. After termination of the work, and before meals, he shall carefully wash his hands and face on the premises.

¹ Gilbert Stone, Laws and Regulations relating to Lead Poisoning, 1922, pp. 226-229.

13. The compositors shall be prohibited from holding type in their mouths and from smoking during work.

14. A sufficient number of spittoons shall be provided in every workroom, and these shall be placed at a height of at least 75 cm. from the floor and be filled with an antiseptic substance, and cleaned once every day. Spitting outside the spittoon is prohibited.

15. The employer shall be bound to see that the provisions obtained in regulations 11 and 12 (paragraph 3), 13 and 14 of these regulations are strictly adhered to. These regulations shall be exhibited in the workrooms. The employers shall be entitled to avail themselves of the provisions of Act No. 4030, "on the payment of wages, etc.," in the case of non-observance of the foregoing regulations on the part of the workers, by which provisions they are entitled to impose fines.

16. The water tanks and jars containing drinking water shall always be carefully cleaned and covered.

17. If any printing works possess typefounding and stereotype installations as accessory departments, these shall be arranged in a special section of the building and be entirely independent and separate from the remaining rooms.

18. The linotype and monotype machines, and generally all machines in connection with typefounding, shall be installed in a special section of the building, entirely independent and separate from the remaining rooms.

19. All machines and furnaces referred to in the foregoing regulations 17 and 18 shall be provided with a separate smoke and steam exhaust pipe, which shall be so fitted that all fumes and heavy gases are sucked off and conducted into the open air.

The main steam and smoke pipe shall be provided at its outlet with a rotating fan or, internally, with a flame of lighting gas, which shall be continually burning during the working of the said machinery, so that, in this manner, all noxious gases and vapours may be easily removed.

20. The employers are prohibited from employing in their concerns workers who are not in possession of a book proving their identity and good state of health.

This book shall be issued by the competent police administration or sub-administration.

A Committee consisting of a police commissary, two police or private physicians, to be proposed by the Prefect, one representative of the employers, and one representative of the workers in the printing trade and holding its meetings at the police office, shall examine every worker appearing before it with respect to his health, and shall declare whether the state of health of the person so examined is such that he may be employed without injury to his health; this Committee shall enter its certificate on a special page of the book of identity and the certificate shall be signed by at least two members of the Committee. If no organizations of the employers and of the workers in the printing trades exists, or if there exist several of such organizations in one and the same place, and these are not able to agree upon the election of representatives or refuse to send representatives to the Committee, the competent police authority shall be entitled to appoint one representative from amongst the employers and one from amongst the workers in the printing trade as members of the Committee.

The employer shall see that the medical examination is repeated every year and that the certificate in question is entered in the book of identity. The Committee shall be competent to pass valid resolutions, if at least the police commissary and one of the police physicians are present.

With respect to the first application of these regulations, the medical examination of the workers by the Committee shall be carried out in the respective printing works in accordance with this regulation.

21. It is prohibited to employ persons under the age of 16 and female persons under the age of 18 in type foundries, stereotyping establishments, and on linotype machines (Section 37 of the Royal Decree dated 11th-24th August, 1913, with respect to the administration of Act No. 4029, concerning the work of women and minors).

22. These regulations shall come into force after the publication of the Royal Decree in question, without prejudice to the provisions of regulations 2, 3 and 8 (par. 1), which shall apply only to printing works to be established in future.

23. Infringements of the provisions of this Decree shall be punishable in virtue of the provisions of sections 3 and 4 of Act No. 3934, with respect to hygienic conditions and safety of workers, and working hours.

CHAPTER XII

SWEDEN

MEMORANDUM FOR WORKERS IN LEAD SMELTERS

Read and observe carefully

What is the cause of lead poisoning?

Lead poisoning may result when lead in one way or another enters the body, for example, by breathing dust, gases, and vapours containing lead. This often happens when one eats, drinks, smokes, or chews in rooms where lead dust and lead vapours are forming. The dust sticks to one's fingers, beard, and lips and thus easily enters the body.

Who is liable to contract lead poisoning?

All persons are liable to contract both it and the serious and painful diseases which are caused by it either immediately or after weeks or months.

Can one escape contracting lead poisoning?

Yes!

How can one escape contracting lead poisoning?

In the first place by observing scrupulous cleanliness.

Be sure in this connection:

To keep the ventilating system in perfect working condition and to report defects at once to the management;

To follow carefully the instructions given by the inspector, the physician or the management;

To wear special working clothes and to keep your other clothes in a room which is totally free from lead dust and lead vapour;

To use mouth and nose protectors whenever lead dust reaches greater proportions than usual;

To rinse your mouth carefully and to wash your hands and face thoroughly whenever your work is finished, both at noon and at night;

Never to take your meals in the workroom;

Never to leave your place of work before you have changed your clothes and washed thoroughly;

To bathe at least once a week;

To rinse your mouth before drinking and never to let your soiled hand come in contact with the edge of the glass;

It is also of importance not to smoke or chew while you are at work, since otherwise the lead dust easily enters your body;

To be temperate in drink. Strong drink, such as beer, wine, and whiskey, should not be touched since they are very injurious to workers in lead smelters. Water, milk and thick soups are strongly recommended. Nourishing food, especially food rich in fats, increases your resistance to lead poisoning;

To keep in the open as much as possible during leisure hours, and to take physical exercise such as walking, gardening, etc.

If you think that you have contracted lead poisoning you should, as much in your own interest as in that of your family, consult your physician at once.

Symptoms of lead poisoning are stomach-ache, catarrh of the stomach and intestines, pains in joints and muscles, trembling of hands and feet, etc.

CHAPTER XIII

INTERNATIONAL RECOMMENDATIONS

Recommendations or conventions adopted by the International Labour Organization of the League of Nations

These recommendations or conventions were adopted at general conferences of the International Labour Organization to which every country of importance belongs and sends representatives. By the constitution of the organization, each country which belongs is pledged to consider the recommendations and conventions with a view to enacting legislation to put the reforms into force. The following are the reforms bearing on lead poisoning which have been recommended:

(1) Women and children in lead industries, Protection of¹

(1) Recommendations adopted by the International Labour Conference at Washington, October-November, 1919.

It was recommended that women and young persons under 18 be excluded from the following processes:

- (a) In furnace work in the reduction of zinc or lead ores;
- (b) In the manipulation, treatment, or reduction of ashes containing lead, and in the desilverizing of lead;
- (c) In melting lead or old zinc on a large scale;
- (d) In the manufacture of solder or alloys containing more than 10 per cent. of lead;
- (e) In the manufacture of litharge, massicot, red lead, white lead, orange lead, or sulphate, chromate or silicate (frit) of lead;
- (f) In mixing and pasting in the manufacture or repair of electric accumulators;
- (g) In the cleaning of workrooms where the above processes are carried on.

It is further recommended that the employment of women and young persons under the age of eighteen years in processes involving the use of lead compounds be permitted only subject to the following conditions:

- (a) Locally applied exhaust ventilation, so as to remove dust and fumes at the point of origin;
- (b) Cleanliness of tools and workrooms;
- (c) Notification to Government authorities of all cases of lead poisoning, and compensation therefor;
- (d) Periodic medical examination of the persons employed in such processes;
- (e) Provision of sufficient and suitable cloakroom, washing, and mess-room accommodation and of special protective clothing;
- (f) Prohibition of bringing food or drink into workrooms.

It is further recommended that in industries where soluble lead compounds can be replaced by non-toxic substances, the use of soluble lead compounds should be strictly regulated.

For the purpose of this Recommendation, a lead compound should be considered as soluble if it contains more than five per cent. of its weight (estimated as metallic lead) soluble in a quarter of one per cent. solution of hydrochloric acid.

(2) The use of white lead in painting²

Draft Convention adopted by the International Labour Conference at Geneva, October-November, 1921.

The General Conference of the International Labour Organization of the League of Nations. Having been convened at Geneva by the Governing Body of the International Labour Office, and having met in its Third Session on 25th October, 1921, and

Having decided upon the adoption of certain proposals with regard to the prohibition of the use of white lead in painting, which is the sixth item of the Agenda of the Session, and

Having determined that these proposals shall take the form of a draft international convention,

Adopts the following Draft Convention for ratification by Members of the International Labour Organization, in accordance with the provisions of Part XIII of the Treaty of Versailles and of the corresponding parts of the other Treaties of Peace.

¹ Labour Gazette, Dec., 1919, p. 10.

² The Labour Gazette, Jan., 1922, pp. 49, 50.

Article 1.

Each Member of the International Labour Organization ratifying the present convention undertakes to prohibit, with the exceptions provided for in Article 2, the use of white lead or sulphate of lead, and of all products containing these pigments, in the internal painting of buildings, except where the use of white lead or sulphate of lead or products containing these pigments is considered necessary for railway stations or industrial establishments by the competent authority after consultation with the employers' and workers' organizations concerned.

It shall nevertheless be permissible to use white pigments containing a maximum of 2 per cent. of lead expressed in terms of metallic lead.

Article 2.

The provisions of Article 1 shall not apply to artistic painting or fine lining.

The governments shall define the limits of such forms of painting and shall regulate the use of white lead, sulphate of lead, and all products containing these pigments, for these purposes in conformity with the provisions of Articles 5, 6 and 7 of the present convention.

Article 3.

The employment of males under 18 years of age and of all females shall be prohibited in any painting work of an industrial character involving the use of white lead or sulphate of lead or other products containing these pigments.

The competent authorities shall have power, after consulting the employers' and workers' organizations concerned, to permit the employment of painters' apprentices in the work prohibited by the preceding paragraph, with a view to their education in their trade.

Article 4.

The prohibitions prescribed in Articles 1 and 3 shall come into force six years from the date of the closure of the third session of the International Labour Conference.

Article 5.

Each Member of the International Labour Organization ratifying the present Convention undertakes to regulate the use of white lead, sulphate of lead, and of all products containing these pigments, in operations for which their use is not prohibited, on the following principles:

- I. (a) White lead, sulphate of lead, or products containing these pigments, shall not be used in painting operations except in the form of paste or paint ready for use.
(b) Measures shall be taken in order to prevent danger arising from the application of paint in the form of spray.
(c) Measures shall be taken, wherever practicable, to prevent danger arising from dust caused by dry rubbing down and scraping.
- II. (a) Adequate facilities shall be provided to enable working painters to wash during and on cessation of work.
(b) Overalls shall be worn by working painters during the whole of the working period.
(c) Suitable arrangements shall be made to prevent clothing put off during working hours being soiled by painting material.
- III. (a) Cases of lead poisoning and of suspected lead poisoning shall be notified, and shall be subsequently verified by a medical man appointed by the competent authority.
(b) The competent authority may require, when necessary, a medical examination of workers.
- IV. Instructions with regard to the special hygienic precautions to be taken in the painting trade shall be distributed to working painters.

Article 6.

The competent authority shall take such steps as it considers necessary to ensure the observance of the regulations prescribed by virtue of the foregoing Articles, after consultation with the employers' and workers' organizations concerned.

Article 7.

Statistics with regard to lead poisoning among working painters shall be obtained:

- (a) As to morbidity—by notification and certification of all cases of lead poisoning
- (b) As to mortality—by a method approved by the official statistical authority in each country.

Article 8.

The formal ratification of this Convention under the conditions set forth in Part XIII of the Treaty of Versailles and of corresponding parts of the other Treaties of Peace shall be communicated to the Secretary-General of the League of Nations for registration.

Article 9.

This Convention shall come into force at the date on which the ratifications of two Members of the International Labour Organization have been registered by the Secretary-General.

It shall be binding only upon those Members whose ratifications have been registered with the Secretariat.

Thereafter, the Convention shall come into force for any Member at the date on which its ratification has been registered with the Secretariat.

Article 10.

As soon as the ratification of two Members of the International Labour Organization have been registered with the Secretariat, the Secretary-General of the League of Nations shall so notify all the Members of the International Labour Organization. He shall likewise notify them of the registrations of ratifications which may be communicated subsequently by other Members of the Organization.

Article 11.

Each Member which ratifies this Convention agrees to bring the provisions of Articles 1, 2, 3, 4, 5, 6 and 7 into operation not later than 1st January, 1924, and to take such action as may be necessary to make these provisions effective.

Each Member of the International Labour Organization which ratifies this Convention engages to apply it to its colonies, possessions and protectorates in accordance with the provisions of Article 421 of the Treaty of Versailles and of the corresponding Articles of the other Treaties of Peace.

Article 13.

A Member which has ratified this Convention may denounce after the expiration of ten years from the date on which the Convention first comes into force, by an Act communicated to the Secretary-General of the League of Nations for registration. Such denunciation shall not take effect until one year after the date on which it is registered with the Secretariat.

Article 14.

At least once in ten years the Governing Body of the International Labour Office shall present to the General Conference a report on the working of this Convention and shall consider the desirability of placing on the agenda of the Conference the question of its revision or ratification.

Article 15.

The French and English texts of this Convention shall both be authentic.

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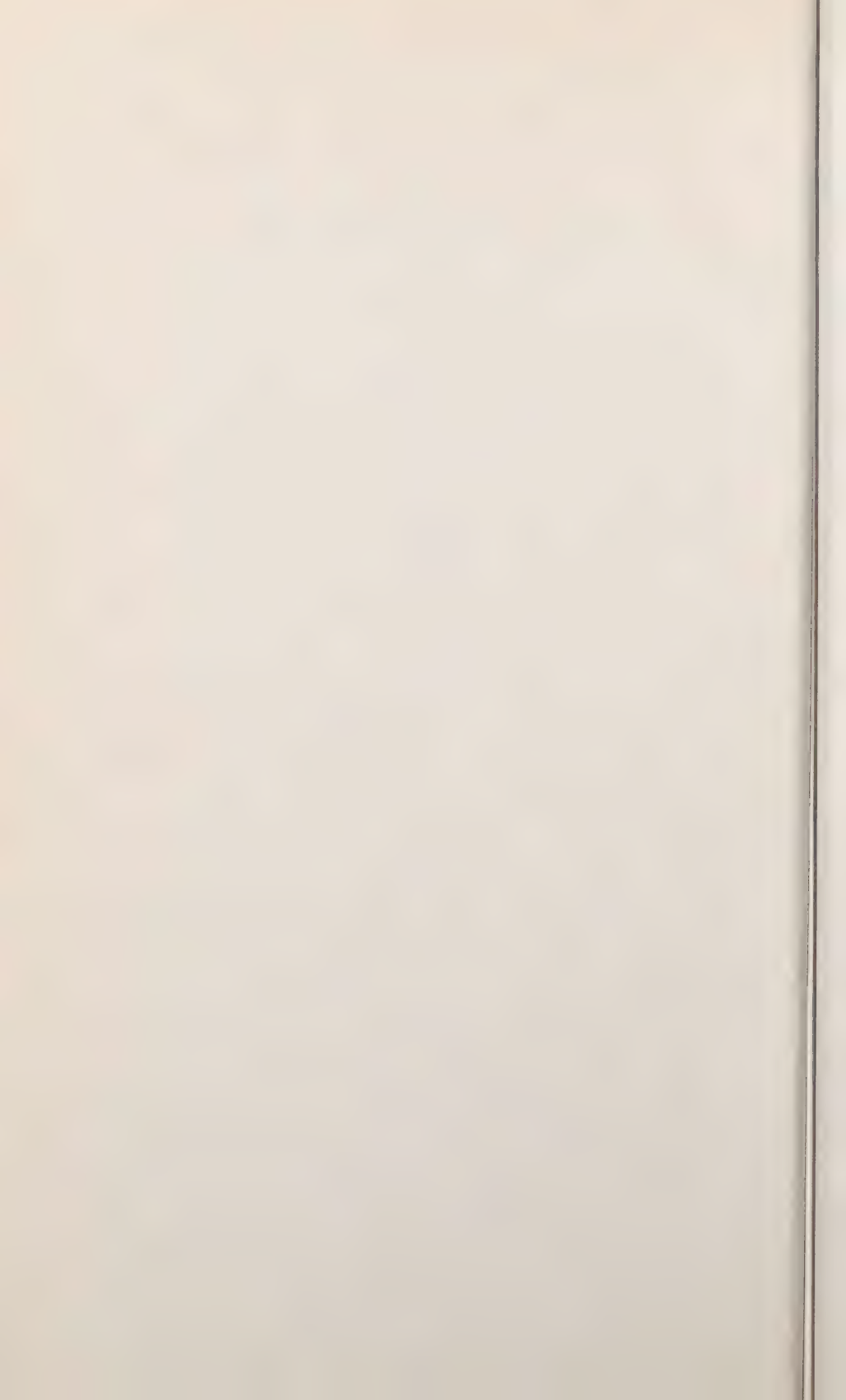
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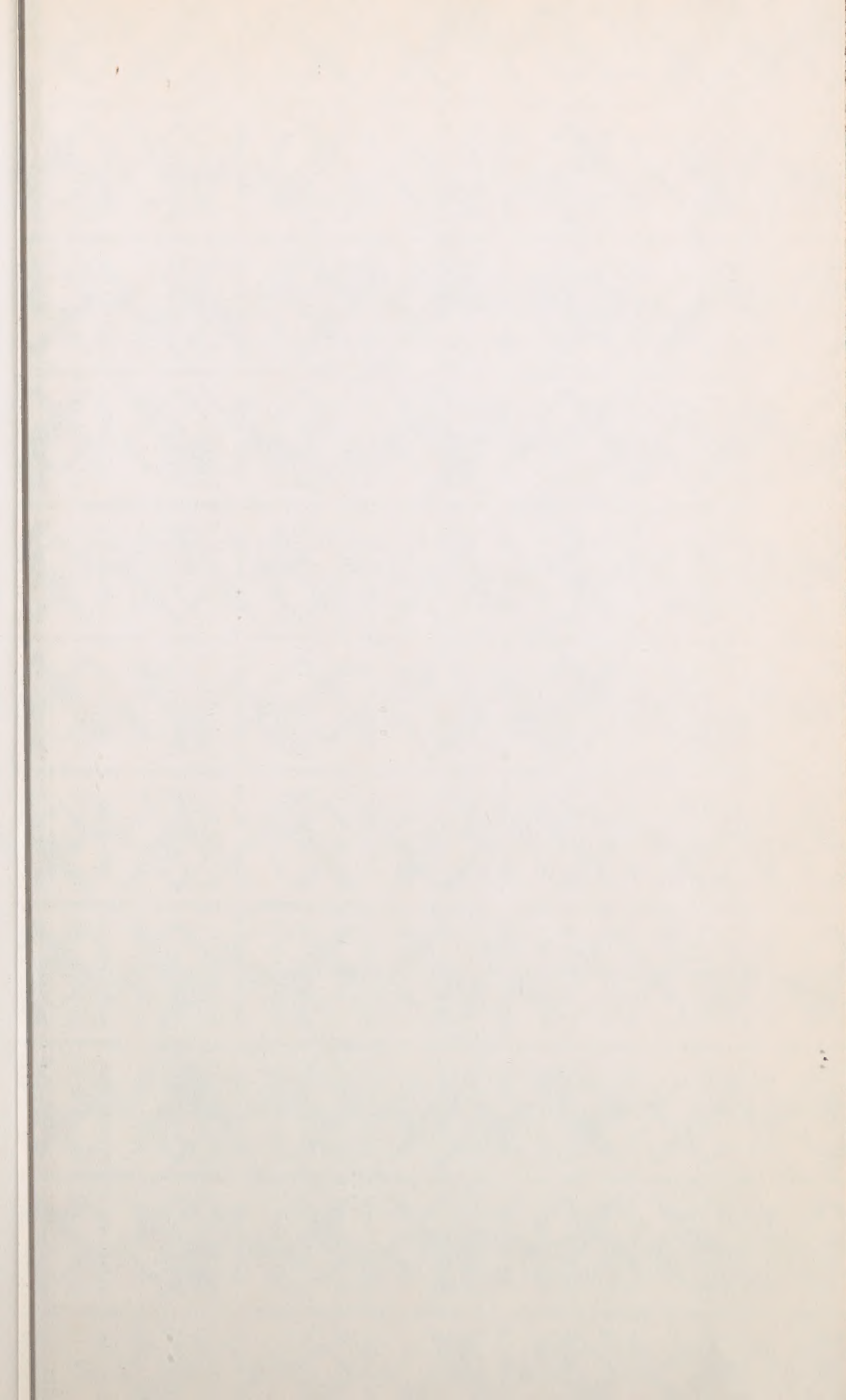
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